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A SYSTEMATIC AND ANATOMICAL ACCOUNT OF THE OPISTHOBRANCHIA

BY

N. B. EALES, D.Sc.

(Zoology Department, University of Reading)

WITH ONE PLATE AND TWENTY-EIGHT TEXT-FIGURES

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INTRODUCTION.

The Opisthobranchs collected by the John Murray Expedition consist of 23 species belonging to 18 genera, and include both Tectibranchs and Nudibranchs. In geographical range they belong to the Red Sea, Gulf of Aden and South Arabian coast as far east as Maskat. Their vertical range is from the surface (*Stylocheilus*) to 220 metres (*Pleurobranchoides*, *Armina*).

Many of the specimens are very small representatives of their species, *e.g. Asteronotus hemprichii*, which attains a length of 90 mm. or more, is in this collection only 32 mm. long. Small animals are often immature, and in some cases it was difficult to decide the species owing to imperfect development, particularly of the reproductive apparatus. Most of the specimens were well preserved internally, though a few (*e. g. Pleurobranchoides*, *Glossodoris*) were torn or macerated before preservation. Many had lost all or nearly all their colour, and it would be helpful for future work if some record of the living animal, at any rate of the larger specimens, could be made before the colour disappears. The painting made by Colonel Sewell of the handsome carmine and white *Hexabranchus sanguineus* was a useful confirmation of the results of anatomical investigation, in a Nudibranch whose radular characters are somewhat variable, and whose colour varieties have been divided by many authors into different species.

For the determination of the species of most of the Opisthobranchs anatomical study is a necessity. The specimens were opened from the ventral surface under a Zeiss binocular dissecting microscope so that the dorsum remains uninjured. Many were photographed before dissection, and wherever possible anatomical details were drawn under the Edinger projection apparatus. A few were injected, others stained temporarily with safranin to facilitate investigation. In describing the general anatomy an attempt has been made to utilize characteristic features for comparative purposes, chiefly with regard to the

nervous and reproductive systems. In the past much confusion has resulted from an investigation of *parts* of the organs, severed from their connection within the body, and unaccompanied by any figure of the entire animal. It is hoped that the photographs and sketches in the present report will be of use not only to the systematist, but also to the comparative anatomist.

My thanks are due to Colonel Sewell and Dr. Calman for giving me the opportunity of examining and reporting on the collection. Mr. R. Winckworth has been most helpful in criticizing and advising me in my work and in suggesting and lending literature. To the British Museum authorities I am indebted for the publication of the Report.

LIST OF OPISTHOBRANCHS REPRESENTED IN THE JOHN MURRAY COLLECTION.

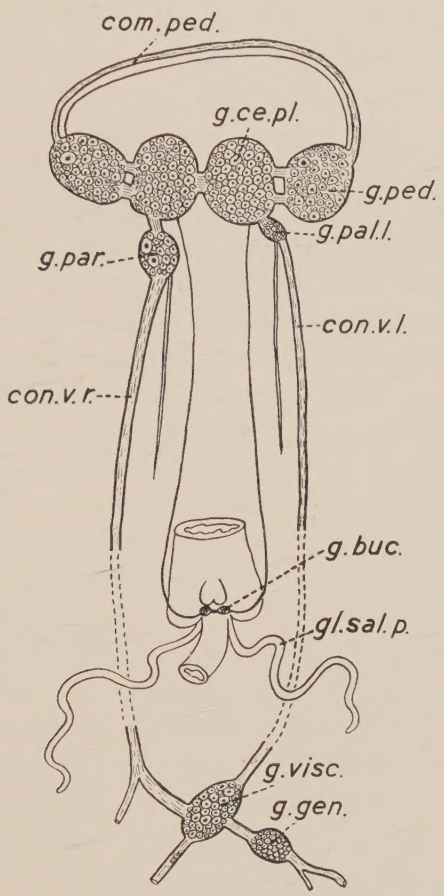
TECTIBRANCHIA .	Cephalaspidea .	Hydatinidæ .	*Hydatina velum* (Gmelin).
		Bullidæ .	*Bulla ampulla* Linn.
		Atyidæ .	*Atys naucum* (Linn.).
			A. cylindrica Helbling.
			Atys sp.
			Phanerophthalmus collaris sp. nov.
	Anaspidea .	Aplysiidæ .	*Stylocheilus longicaudus* Quoy & Gaimard.
	Notaspidea .	Pleurobranchidæ	*Pleurobranchoides* sp.
NUDIBRANCHIA .	Doridomorpha .	Hexabranchidæ .	*Hexabranchus sanguineus* (Rüppell & Leuckart).
		Polyceridæ .	*Nembrotha lineolata* Bergh.
		Doridæ.	
		Glossodoridinæ	*Glossodoris* sp.
		Doridinæ .	A Dorid.
		Discodoridinæ .	*Discodoris* sp.
		Asteronotinæ .	*Halgerda willeyi* Eliot.
			H. apiculata (Alder & Hancock).
			Asteronotus hemprichii Ehrenberg.
			Asteronotus sp.
		Arginæ .	*Artachæa intermedia* sp. nov.
		Phyllidiidæ .	*Phyllidiella pustulosa* (Cuvier).
	Eolidomorpha .	Arminidæ .	*Dermatobranchus striatus* v. Hasselt.
			Armina semperi (Bergh).
			A. tæniolata Bergh.
		Scyllæidæ .	*Scyllæa pelagica* Linn., var. *orientalis* Bergh.

Hydatina (*Aplustrum*) *velum* (Gmelin). (Text-fig. 1 ; Pl. I, fig. 8.)

Aplustrum velum, Bergh, S.R.,* 1901, p. 242, taf. 20 and 21 ; Vayssière, 1906, p. 29, pl. iii, figs. 52–54; pl. iv, fig. 55.

Occurrence.—Sta. MB II (*a*). Arabian coast, 11 metres ; one specimen, 15 mm. long, 10 mm. wide, the shell 9 mm. high.

Distribution.—Pacific and Indian Oceans.



Text-fig. 1.—*Hydatina velum*. The nervous system viewed from the ventral side. The full length of the visceral cords is not shown ; they are nearly twice as long as in the figure. × 14. (For explanation of reference letters used in the Text-figs. see list at p. 119.)

Descriptive Notes.—The external features and shell of this beautifully-marked species are well known, and both Bergh and Vayssière have described the internal anatomy. Only certain features regarding the gut and nervous system are therefore described here.

The alimentary canal is remarkable both for its length and its contents. On opening up the body from the ventral side, it was seen that a voluminous crop with extremely thin walls filled the greater part of the body cavity. Through the wall glistening setæ were visible, and these proved to be those of a Cirratulid worm, 80 mm. long and 4 mm.

* The initials S.R. refer throughout this Report to the publication, ' Semper's Reisen im Archipel der Philippinen '.

wide, more than five times as long as the *Hydatina* which swallowed it. Bergh noted a similar worm in his specimen, so that the mollusc is probably highly selective in the choice of its food. The buccal mass is of astonishing length, being 30 mm. long and coiled up on the right side of the body, where it is pushed owing to the amount of food in the crop. It consists of a long muscular tube, little varied in width along its length. The posterior end is rounded, and from its ventral wall projects a small bilobed radular sac. The whole apparatus is moored by slender retractor tendons to the body wall, and the radular portion is attached to the oral portion by a pair of tendons. The nerve ring surrounds the buccal mass anteriorly, close to the external aperture. As in the Bullidæ, the pedal commissure is the most anterior part of the ring. The buccal ganglia lie near the radular sac, so that the cerebro-buccal connectives are long, though as they are considerably shorter than the buccal tube itself, it can be inferred that the tube cannot be fully extended. There are two pairs of salivary glands. The anterior pair, sometimes called the ptyalin glands, are fastened posteriorly by connective tissue to the sides of the buccal mass and discharge anteriorly near the mouth aperture. They form rather thick tubes. The posterior glands are very slender, sinuous structures opening into the pharyngeal groove on the dorsal side of the buccal mass. The œsophagus is at first narrow, but soon expands into a very large crop, which contracts again to form the stomach. There is no gizzard. The stomach is surrounded by the digestive gland, and receives several large bile ducts. The intestine is relatively short and the anal aperture lies on the summit of an anal tube. The buccal mass contains jaw plates and a rather small radula. The hooked rods of the former and the elongated 3- or 4-toothed plates of the latter have been clearly depicted by Bergh (S.R. 1901, Taf. 20, fig. 47 and Taf. 21, figs. 1–7). The formula for the specimen is 15.0.15, and there are 28 rows of teeth. On the naked rachis is a very minute flat plate, which may represent a vestige of the rachidian tooth.

The nervous system (Text-fig. 1) exhibits a more highly concentrated condition than that of the Bullidæ, though similar elements can be traced in it. The most anterior portion of the nerve ring is the double pedal commissure. The pedal ganglia are, however, in a line with the cerebral, and since the cerebral commissure is extremely short, all the ganglia lie towards the dorsal side, in contrast to their lateral position in the Bullidæ. The cerebral mass evidently represents a fusion of cerebral and pleural ganglia, as it is linked with the pedal ganglion by two connectives. Moreover, the pleuro-visceral cords emerge from the posterior or pleural portion of the mass. The left cord enlarges almost at once into a small ganglion which gives off a nerve dorsally. This is the left pallial ganglion (*g. pal. l.*). The course of the cord is beside the gut as far as the posterior border of the large crop. It then crosses the gut ventrally and here forms a large ganglion, representing the fused infra-intestinal and visceral ganglia (*g. visc.*). A stout nerve with a few odd nerve cells near its origin travels to the columellar muscle ; a small nerve passes to the left beside the hermaphrodite duct and forms the usual genital ganglion (*g. gen.*) and genital nerve. The right pleuro-visceral cord has a large ganglion near its exit from the cerebro-pleural mass. This ganglion gives off a slender nerve which forms a pair with that from the left pallial ganglion, whence the inference is that the ganglion has been formed by fusion of right pallial and supra-intestinal ganglia (*g. par.*). The cerebro-buccal connectives pass backwards to the pair of small buccal ganglia (*g. buc.*) situated in their usual position close to the radular sac. All the ganglia are enclosed in connective-tissue capsules.

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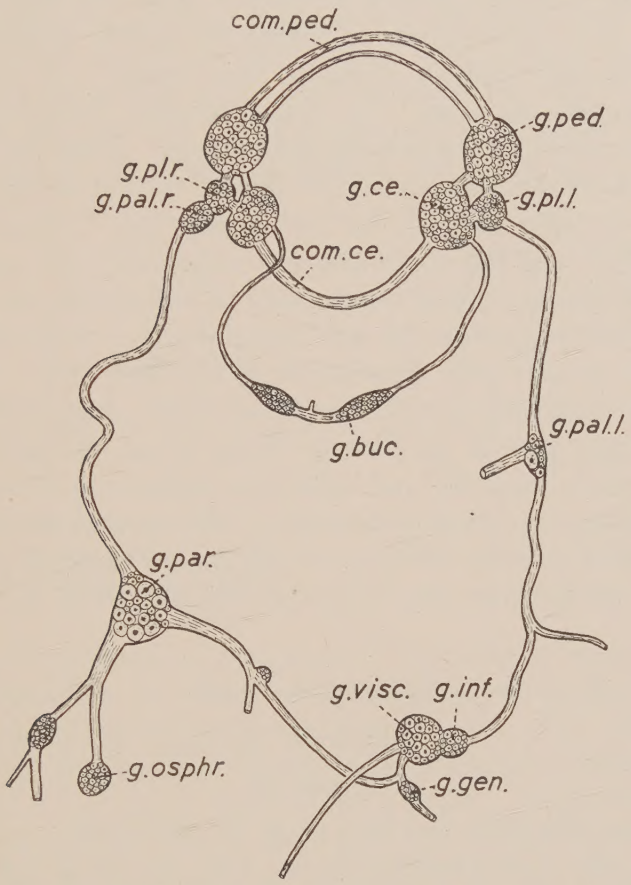
Bulla ampulla Linn. (Text-fig. 2.)

Bulla ampulla, Bergh, S.R., 1901, p. 210, taf. XVIII, figs. 9–25 ; Vayssière, 1906, p. 18, pl. ii, figs. 27–33.

Occurrence.—Sta. MB II (*a*). Coastal zone, Arabian coast, 28.x.33, 9 metres ; one specimen, whose shell is 18 mm. long, 11 mm. wide and 9 mm. high.

Distribution.—Coasts of India and Eastern Africa.

Descriptive Notes.—The external features and shell of this species are well known. In its jaw rods, radula and gizzard plates the specimen agrees with the type. The radula



Text-fig. 2.—*Bulla ampulla*. The nervous system viewed from the ventral side. The supra-intestinal ganglion is dorsal to the gut, the infra-intestinal and visceral ganglia lie ventral to it. × 14.

had 20 rows of central teeth, but only 18 rows of laterals, the formula being 3.1.3. The outermost lateral is a simple plate without cusp or denticles; the second lateral is denticulate on one side and the first lateral on both sides. As neither Bergh nor Vayssière gives a description of the nervous system, an account is here appended. The nervous system (Text-fig. 2) exhibits a primitive separation of the main ganglia of the nerve ring, while at the same time showing certain specialized features. The nerve ring consists of paired cerebral, pleural and pedal ganglia, and on the right side a small pallial ganglion (*g. pal. r.*) follows the pleural ganglion. The cerebral ganglia are very widely spaced, and both the cerebral and the double pedal commissures are very long. The most anterior ganglion

of the set is the pedal, the most posteriorly placed the cerebral, while the pleurals are lateral. Cerebro-pleural, cerebro-pedal and pleuro-pedal connectives are distinct. The cerebro-buccal connectives are long, and allow of considerable movements backwards and forwards of the buccal mass. In the specimen, owing to strong retraction of the buccal mass, the buccal ganglia (*g. buc.*) lie posterior to the nerve ring, but when the mass is thrust forwards, they would be carried with it through the ring. The cerebral ganglia, however, are fixed in the position they occupy postero-dorsal to the pedal ganglia, a situation which may be related to the backward position of the rhinophores. From the right pleuro-pallial ganglionic centre a connective passes alongside the gut, but slightly towards its dorsal side, swelling near the gizzard to form a large flat supra-intestinal ganglion (*g. par.*). From this two nerves arise, of which the *lateral* supplies the osphradium, becoming ganglionated immediately beneath that organ. A dorsal branch, also ganglionated, runs towards the anus. The *mesial* division bears a few nerve cells, and passes over the ventral side of the gut towards the left cord. From the left pleural ganglion a connective passes backwards, beside the left side of the gut at first, then crossing the gizzard ventrally it converges towards the right connective. I was unable to follow the connection between right and left cords owing to a break in this region, but dissection of a specimen of *Bulla striata* enabled me to trace it, and it may be assumed to exist in *B. ampulla*. About half-way down the left connective is a very small pallial ganglion (*g. pal. l.*), from which a nerve goes dorsalwards to the body wall. On the ventral side of the gizzard are two contiguous ganglia, the first a rather small infra-intestinal (*g. inf.*), the second a much larger visceral ganglion (*g. visc.*). From the latter two nerves arise, of which one turns postero-ventrally and splits into two, a genital nerve, and the nerve which presumably joins its fellow connective. The genital nerve runs beside the hermaphrodite duct after passing through a small genital ganglion (*g. gen.*). The other branch from the visceral ganglion travels postero-dorsally along the columellar muscle, which it supplies.

Atys naucum (Linn.).

A. cylindrica Helbling.

Atys sp.

Occurrence.—Sta. MB I (*b*), Red Sea, 17.ix.33, 29 metres.

Four dead shells, one of *A. naucum*, 15 mm. long, two of *A. cylindrica* 12 mm. and 4 mm. long respectively, and one of a more heavily built species only 3 mm. long.

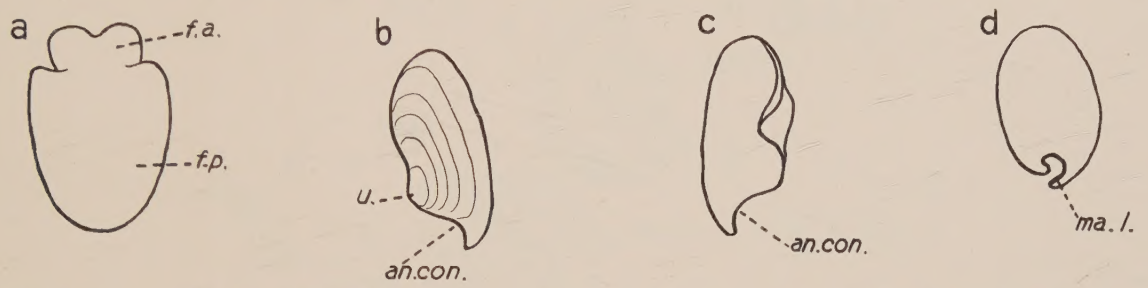
Phanerophthalmus collaris sp. nov. (Text-figs. 3–6 ; Pl. I, fig. 2.)

Occurrence.—No station was given, but the date, 12.x.33, and depth, 15 to 40 fathoms, indicate that the specimen must have been taken at Sta. 27, Gulf of Aden, near Cape Guardafui, depth 37–91 metres.

Descriptive Notes.—Length 8 mm., breadth 6 mm., height 3·5 mm. Of a broadly oval shape, wider anteriorly than posteriorly, though the posterior end is rounded. The body is soft, without papillæ or tentacles. It is greenish in colour, except where the dark viscera show through the dorsal surface. The two large, circular, intensely black eyes shine through the skin of the cephalic shield. Postero-dorsally lies a porcellaneous white shell, 3·5 mm. long and 2 mm. wide, apparently external, and with its lines of growth

running longitudinally, the umbo on the left (Text-fig. 3*b* and *c*). At this side the shell is thicker, but there is no trace of a spiral. The posterior border is incised for the passage of the anus. The edges of the shell are yellow. A very thin, transparent mantle covers it, but the covering is so delicate that the shell was at first thought to be external. Only on attempting to move the shell was it found to be held in place by the mantle, so that, as in other species of *Phanerophthalmus*, the shell is internal or intra-pallial.

The body is depressed, flatter dorsally than ventrally, where the foot, devoid of a pedal sole, is rounded in transverse section. This flattening of the dorsal surface reaches its extreme in the cephalic shield, which is no more than a thin flap, slightly broader than long, notched deeply on its anterior rounded border, and curving inwards posteriorly, but not reaching the middle line, where a gap about 1 mm. wide occurs. Thus the cephalic shield overhangs the body anteriorly and laterally, and, in part, posteriorly. The black eyes shine through the dorsal side of the shield at about its centre. Postero-laterally the shield overlaps and is fastened to a pair of structures shaped like epaulettes—small brown triangular flaps which run up under the sides of the shield for a short distance. The



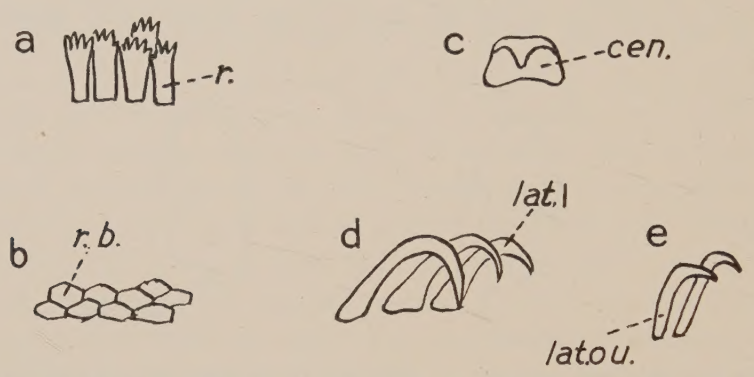
TEXT-FIG. 3.—*Phanerophthalmus collaris*. *a*, Foot to show anterior and posterior divisions. × 3. *b*, Shell from the dorsal side. × 7. *c*, Shell, ventral view. × 7. *d*, Mantle, to show lappets and anal (pallial) aperture. × 7.

ventral surface of the flap consists of from 12 to 15 filaments set transversely and somewhat obliquely. These organs are the rhinophores, called the osphradia by some authors, but homologous with similar structures in the Bullidæ, etc. The head bears no distinct tentacles, but under the overhanging anterior bilobed flap of the shield is a pair of ridges, in the same position as the larger ridges in the Bullidæ. These may be vestiges of oral tentacles. Connecting the rhinophore flaps is a faint transverse ridge on the dorsum. This may be a separated portion of the cephalic shield, but it is indistinct in the specimen. The dorsal body wall is ridged transversely. Posteriorly, almost in the middle line, is the anus, postero-dorsally the shell, and on the right postero-laterally a plumose ctenidium, whose apex is directed backwards. The external genital aperture is covered by the ctenidium, and from the aperture an open seminal groove runs forward along the whole length of the right side of the animal to the penis, situated on the right side of the head.

The foot is flabby, without defined creeping surface. It is divided into two portions, anterior and posterior, by deep lateral incisions (Text-fig. 3*a*). The anterior portion lies beneath the cephalic shield and is similar to it in size and shape. Anteriorly it reaches to the foremost limit of the shield, and its anterior border is bilobed to match the latter. The posterior portion is about four times as long as the anterior, and is also much wider. Its sides are prolonged into a pair of parapodia, which curve dorsalwards over the back, but are not long enough to hide the shell and dorsum. The lateral seminal groove, genital

aperture and ctenidium may, however, be covered. Anteriorly this portion of the foot forms a kind of upstanding collar round the body; posteriorly the parapodia are fused and drawn tightly over the posterior end of the body, so that they make a secondary pallial cavity. From the above description it is obvious that the foot is longer than the body owing to this posterior extension. The mantle, on the other hand, is very small (Text-fig. 3*d*). It encloses the shell as a thin transparent layer, but its posterior border is thickened, and prolonged into two unequal processes which curve round the anus and form the outlet for the reduced pallial cavity. The right process, which is longer and more curved than the left, is partly supported by the beak of the shell, into the concavity of which the anus fits.

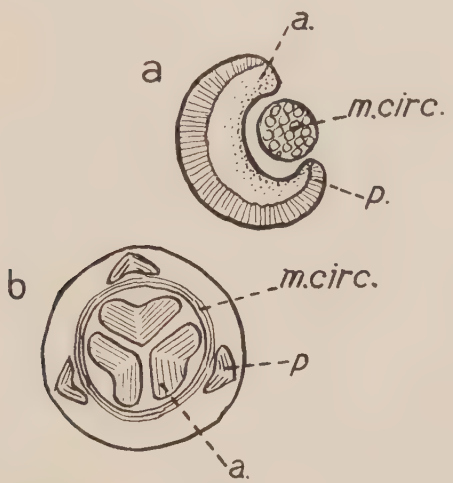
The alimentary canal resembles that of other members of the family in its general features. The buccal mass is well developed, though the jaws and radula are very slender and small. Each jaw plate is hemispherical and bears about 20 rows of very minute rods.



TEXT-FIG. 4.—*Phanerophthalmus collaris*. *a*, Five rods from the jaw. Lateral view. × 500. *b*, Bases of the jaw rods. × 500. *c*, Rachidian tooth of the radula. × 500. *d*, First three lateral teeth. × 500. *e*, Two outer laterals. × 500.

On the under-surface these rods, owing to their regular arrangement in alternate series, present a tesselated appearance (Text-fig. 4*b*); on the upper surface each rod broadens to form a curved and overlapping surface for the next rod, the free edge being provided with four or five finger-shaped denticles (Text-fig. 4*a*). The broadening of the rods at the free end is peculiar. The radula is very small, and its narrowness in the specimen was exaggerated by rolling of the edges. In attempting to flatten it, some dislocation of the teeth occurred. As far as could be ascertained there are 20 rows, with an average formula of 12.1.12, though some rows have a few more teeth than this. The central (Text-fig. 4*c*) is a very small tooth, with an almost square thin base and a single narrow pointed cusp, on which no denticles could be seen. The laterals (Text-fig. 4*d* and *e*) are all alike, differing only in the length of the slender cusp. The base is narrow, without a shoulder, the whole of it bending over to form the curved cutting surface, which slopes towards the centre of the radula. A pair of long, slender salivary glands open into the buccal cavity, and are fastened posteriorly by connective tissue to the gizzard. At this point the œsophagus, just before expanding into the gizzard, bears a small pouch on the right side, but this may be an abnormality. The gizzard is a trifoliate structure situated on the right anterior border of the digestive gland. Its three dark gizzard plates are set longitudinally in the wall, and are bound together by a strong circular band of muscle

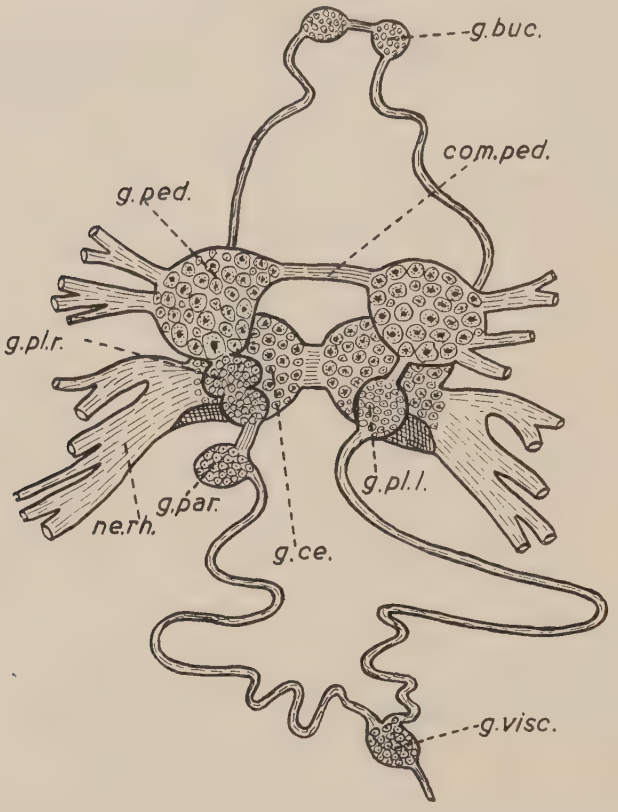
lying in the gizzard wall. Each gizzard plate (Text-fig. 5*a* and *b*) is thick and arcuate, of a shape common in the family, and marked by two rows of very fine, transversely arranged parallel ridges set in pent-house fashion. The convex side of the plate is directed towards the cavity of the gizzard, the concave side towards its wall. The convex side is also the keeled striated side. Into the concavity fits very neatly the circular band of muscle fibres, which thus not only binds the plates together, but by its contraction brings the grinding surfaces together. Since these grinding surfaces are curved, there will also be a longitudinal movement, whereby crushed food is passed on in a manner recalling peristaltic action in other animals. The bile ducts enter on the dorsal side of the narrow stomach, and the intestine passes ventrally to the left, then loops round dorsalwards and back along the right side towards the posteriorly situated anus. It is embedded in liver tissue although exposed on the surface. The digestive gland is relatively very large, occupying, with the hermaphrodite gland, about two-thirds of the body space.



Text-fig. 5.—*Phanerophthalmus collaris*. *a*, Lateral view of gizzard plate and circular muscle of gizzard. × 10. *b*, Gizzard in anterior view to show the three curved gizzard plates into whose concavity the circular muscle fits. × 5.

The reproductive system is very minute and it was not possible to investigate all the details. The hermaphrodite gland is closely bound up with the digestive gland, appearing here and there on the surface, its whiteness in marked contrast to the brown colour of the latter. The hermaphrodite duct emerges posteriorly close to the point at which the rectum frees itself from the digestive gland. An albumen gland and pear-shaped spermatocyst are present, the latter lying within the terminal coil of the hermaphrodite duct. On the right, close to the kidney and heart, is a globular spermatheca communicating by a slender duct with the vagina. The common genital aperture lies at the anterior end of the ctenidium, and is thus posteriorly placed on the animal's right side. An open seminal groove leads from this to the penis, lying on the right side of the head, beneath the cephalic shield, and at about the transverse level of the eyes. The penis has a very slender retractor muscle, and from the inner end of its sheath arises a long sinuous duct which passes dorsally across the body, enlarging to form an elliptical prostate. The penis is unarmed but bears soft nodular processes.

The nervous system (Text-fig. 6) exhibits several peculiar features. Of the ganglia which encircle the œsophagus, the ventral pedal ganglia (*g. ped.*) are the most anteriorly placed, so that the pedal commissure is actually anterior to the cerebral commissure. The flattening of the head and the position of the eyes and rhinophores far back on the cephalic shield may be responsible for this. A second peculiarity is the thickening of the nerves supplying the rhinophores (*ne. rh.*), and an especially dense region on the posterior border of the main nerve. A third is the asymmetry of the pleuro-visceral group of ganglia. On the right side the pleural ganglion (*g. pl. r.*) is partly divided, and there is a separate ganglion joined to the divided ganglion by a connective. On the left side there is



Text-fig. 6.—*Phanerophthalmus collaris.* Nervous system from ventral side. × 45.

only a single ganglion (*g. pl. l.*). On each side a long connective runs lateral to the digestive gland and joins its fellow postero-dorsally close to the genital complex, swelling into an irregularly-shaped ganglion. From a comparison with other Tectibranchs and from what can be worked out of the innervation of the parts in so small a specimen, the interpretation of these ganglia is as follows: The subdivided ganglion on the right side represents the right pleural and right pallial ganglia; the separated ganglion of that side is the supra-intestinal ganglion (*g. par.*). The ganglion of the left side represents fused pleural and pallial ganglia, while the posterior ganglion at the end of the long connectives is formed from the combined infra-intestinal, visceral and genital ganglia (*g. visc.*). The buccal ganglia (*g. buc.*) occupy their usual place on the ventral side of the œsophagus. Their position relative to the ring will be affected by the movement of the whole buccal mass

backwards and forwards. It should be noted, however, that Bergh's fig. 4, taf. 13 in 'Semper's Reisen' (*Cryptophthalmus*) has probably been drawn upside down in an attempt to get the cerebral commissure into an anterior position. That this is an error is shown by the way in which he has threaded the pleuro-visceral connectives through the nerve ring in order to get them into a posterior position. Bergh noted the subdivision of the right pleural ganglion, but did not find a separate supra-intestinal ganglion in *Cryptophthalmus*.

The recorded species of *Phanerophthalmus* are four in number, and all occur in the Pacific area, from New Guinea and the Celebes Sea to Fiji and New Caledonia. *P. luteus* (Q. et G.) (*vide Bulla lutea*, Quoy & Gaimard, 1932, t. 2, p. 369, pl. xxvi, fig. 40; *P. luteus*, Bergh, S.R., 1901, p. 297, pl. xxv, figs. 3–22, and 1905, p. 36) has an elongated body, undivided foot, shell hidden, internal, white, longitudinally placed, with the umbo on the left, without a spire, but with a projecting posterior border. Eyes and rhinophores small. Radula broad, 48 rows, formula 32.1.32. From 6 to 30 mm. long, nearly three times as long as broad. Fiji, New Guinea, Celebes Sea. *P. pauper* Bergh (1905, p. 37) has an undivided foot which is bilobed anteriorly. Shell hidden in the mantle, its lines of growth longitudinally placed, without spire, but with projecting posterior edge and umbo on the left. Eyes not visible through the skin. Mantle with two lappets posteriorly. Radula broad, 48 rows, 20.1.20, central with three teeth, 14 mm. long. Celebes Sea. *P. perpallidus* Risbec (1928*b*, p. 39) has an elongated body, undivided foot shorter than the cephalic shield, transparent transversely placed shell with posterior spiral directed towards the *right* side. Eyes distinct. No rhinophores. Radula 50 rows, 12.1.12, 7 mm. long, twice as long as broad. New Caledonia, South Pacific. *P.* (*Xanthonella*) *engelii* (Labbé) (Labbé, 1934, p. 6). Body ovate, foot undivided. Shell intra-pallial, reduced, rectangular, horny, thin and little calcified, placed transversely on the body, with umbo on the *right* and a projecting process. No eyes visible. Rhinophores minute. Radula as above, but no formula given. 10 mm. long, about twice as long as broad. New Guinea.

The present specimen differs from all the above but resembles *P. pauper* in some of its characters. It is, moreover, the first member of the genus to be recorded outside the Pacific area. The name *P. collaris* is proposed for it, and refers to the collar-like parapodial lobes. The species can be thus defined: Body very broad and plump, the breadth considerably more than half the length. Cephalic shield large, divided into anterior and posterior portions. The anterior is broad and overhangs anteriorly and laterally; the eyes shine through its dorsal surface and it is strongly bilobed over the mouth. The posterior part is narrower and smaller, is fastened to the back and bears the rhinophores laterally. Shell white, longitudinally placed, without spire, but with projecting posterior border and umbo on the left. Covered with a very thin layer of mantle so that it appears to be external. Mantle prolonged backwards round the anus in the form of two asymmetrical lappets, similar to those of *P. pauper*. Foot divided into anterior and posterior portions by a pair of deep lateral incisions. Anterior portion of the foot resembling the anterior part of the cephalic shield in size and shape, posterior portion much wider and prolonged laterally to form a pair of parapodia which stand up round the body, form in front a collar, and fuse behind to provide a secondary pallial cavity. Radula narrow, delicate, about 20 rows, with a formula of 12.1.12 non-denticulate teeth, 8 mm. long, 6 mm. wide. Gulf of Aden.

Stylocheilus longicaudus Quoy et Gaimard. (Text-figs. 7–9.)

Aclesia striata, Risbec, 1925*b*, p. 49.
Stylocheilus longicaudus, Engel, 1936, p. 57.

Occurrence.—Sta. 25, Gulf of Aden, near Cape Guardafui, 10.x.33, surface.

Distribution.—Indo-Pacific area from Red Sea to Japan and New Guinea and African coast; Atlantic area, West Indies.

Descriptive Notes.—This tiny Aplysiid measures only 6 mm. in length, 3 mm. in breadth, and 4·5 mm. in height. It has no markings or colour, and owing to the way in which it has contracted, it looks like an *Aplysia* at first sight. But the body is more slender, there is a distinct long tail, the flat, simple lobes of the oral tentacles are better defined, the parapodia are smaller and are fastened tightly on the back. Moreover, the genital aperture is outside the dorsal slit, and since the parapodia are barely 1 mm. apart anteriorly at their point of attachment to the body, the genital groove seems to be very

Text-fig. 7.—*Stylocheilus longicaudus*. *a*, Two rows of teeth from the radula, showing central and the first two laterals on each side. × 400. *b*, Outermost lateral. × 400.

high near its origin. The mantle is reduced, has no aperture, and there is no trace of a shell. On the other hand, the skin exhibits neither papillæ nor definite markings, both of which are characteristic of the genus *Stylocheilus*; but this is a very young specimen, and the colour may have dissolved out. There is a circular spot on the right parapodium which may have been an ocellus.

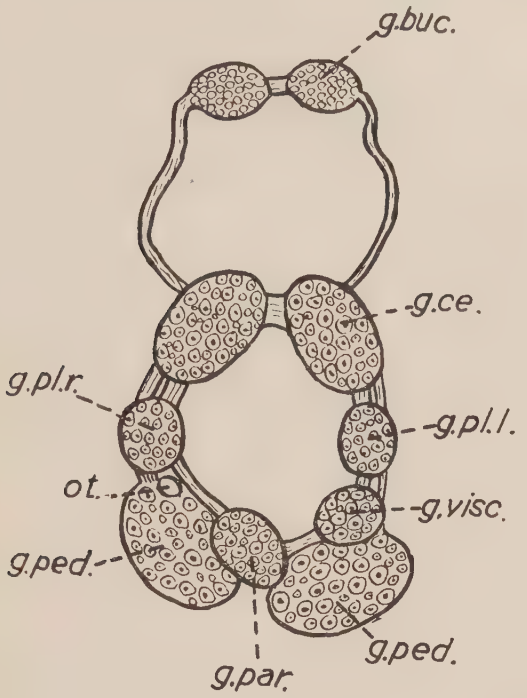
Internally there is no difficulty in identifying the specimen as a *Stylocheilus*, since the characters associated with the radula, the nervous system and the male copulatory apparatus are diagnostic.

The mouth aperture is lined by a folded chitinous layer exhibiting tooth-like structures in two places:

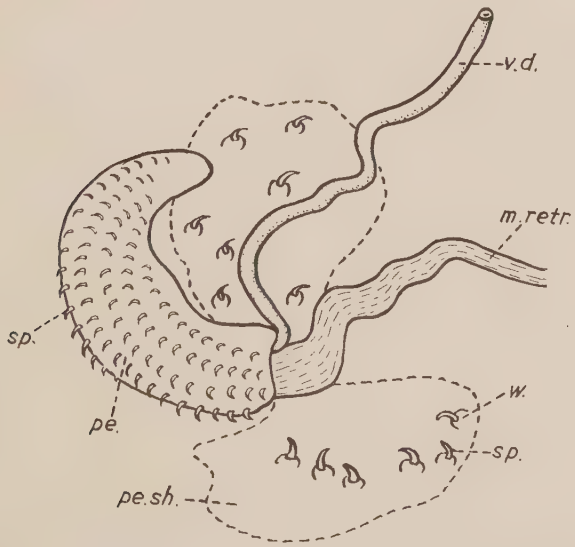
(*a*) Near the entrance are two jaws composed of closely packed rod cells, each cell rather broad and rectangular with an obliquely truncated top or free surface, prolonged at one corner into a small beak. There are about 24 rows of these rods in each jaw plate.

(*b*) Along the walls of the dorsal pharyngeal groove at the point where this leaves the buccal cavity to pass into the œsophagus there are two tracts of spines, consisting of curved hooks directed backwards. The hooks arise from elongated bases, the anterior end of the base, near the convex side of the hook, being prolonged as a shoulder, so that some of the hooks have a bifid appearance.

The radula (Text-fig. 7*a* and *b*) consists of 25 rows of teeth, the first row having a central only, the second row 8 laterals per side, the third 10, the fourth 13, and so on up to a maximum of 20.1.20. The central is on a broad diverging base hollowed out in the



TEXT-FIG. 8.—*Stylocheilus longicaudus*. Nervous system, ventral view. × 52.



TEXT-FIG. 9.—*Stylocheilus longicaudus*. Penis and penis sheath, the latter cut open along the dotted line. × 48.

centre so that the side pieces resemble the legs of an easel. Its anterior portion is also grooved mesially where the base turns over in the cusp. The latter is short and strong, with from 2 to 3 undivided lateral denticles, little smaller than the main cusp. The first lateral is three-pronged and asymmetrical; the remaining laterals increase in length as

their distance from the centre increases, but they decrease in strength. They have long narrow recurved cusps with numerous denticles on one side, and they overlap one another so much in the specimen that it is difficult to count them.

The nervous system (Text-fig. 8) is more concentrated than in the Aplysiinæ, although all the ganglia are distinct and rounded, with clear connectives. Cerebral, pleural, pedal and buccal ganglia are grouped round the œsophagus. The pedal commissure is very short. Close to the nerve ring are drawn up the supra-intestinal (parietal) and visceral (infra-intestinal and visceral) ganglia to make an almost symmetrical pair, rather to the right side of the ring. These two ganglia are connected with the pleural ganglia of their own side by pleuro-visceral connectives, and with one another by a visceral connective. Each pedal ganglion has the usual otocyst (*ot.*) lying on its anterior border.

The genital complex is too small for investigation, but the penis (Text-fig. 9) was extracted and mounted. It shows the characters of the genus, being long and narrow, armed all over except at the tip with longitudinal rows of backwardly-directed spines, not set on warts. The preputium or penis sheath is also spiny, but these spines are few in number and each is erected on a wart-like base. There is no penial collar.

Pleurobranchoides sp. (Text-fig. 10*a* and *b*.)

Cf. Pleurobranchoides gilchristi, O'Donoghue, 1928–9, p. 62 ; Eales, 1937, p. 371.

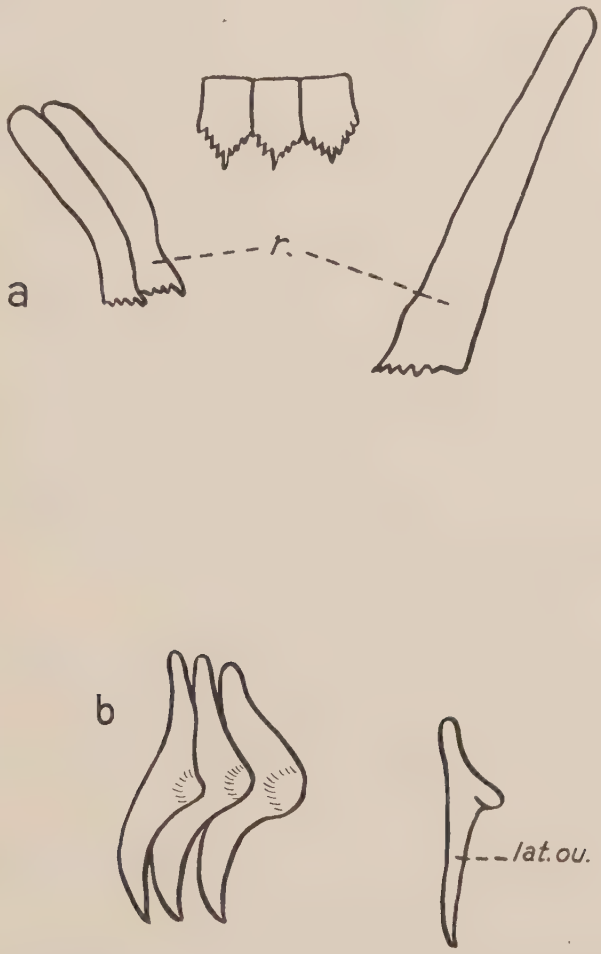
Occurrence.—Sta. 194, Gulf of Aden, 7.v.34, 220 metres ; one specimen, much damaged. Length 85 mm., breadth 65 mm., height 24 mm., but greatly flattened out of the normal. The body must have been plump and elliptical in shape, but the specimen is now in a bad state as though it had been partially decomposed and placed in a rusty receptacle before being immersed in spirit. The notum and side of the body are torn, and most of the internal organs are either badly decomposed or lacerated.

Descriptive Notes.—The skin is smooth, much wrinkled, but without colour or markings. The head is not completely separated from the notum as in many Pleurobranchids ; it is very broad, with widely-spaced anterior (oral) tentacles, 42 mm. from tip to tip. These tentacles, with the fleshy region between them, form a cephalic veil, which is set on a lower level than the notum and has an almost straight anterior border, with the tentacles standing out laterally. There is a constriction between the cephalic veil and the rhinophores, the latter being only 30 mm. apart, short, auriform, and projecting laterally also. The notum commences between the rhinophores in the form of a narrow but steadily increasing fold projecting over the head region, but on a higher level. Its border forms a kind of shoulder laterally, then extends down the sides of the body, overhanging the foot laterally and posteriorly. In other words, the mantle is much larger than the foot, the reverse being the case in *Pleurobranchœa*, though in that genus the general body form is similar. There is no shell. The large bipinnate gill plume on the right side is 40 mm. in length and bears a double row of pigmented nodules on the rachis. The anterior margin of the foot is rounded, with a bifid border. It is 65 mm. long and 35 mm. broad.

The mouth aperture has a pair of very large, dark brown jaw plates, 20 mm. long, 11 mm. broad, very thin anteriorly, but much thicker posteriorly. They are composed of very compact, tall rods, each shaped like an elephant's foot, *i. e.* bent near the broad truncated apex, and extended a little at one corner (Text-fig. 10*a*). The free edge is

denticulate, so that each rod is really cusped, with numerous side denticles, the cusp overlapping the next rod. In surface view the plate has the appearance of a piece of plant tissue owing to the extreme regularity of the rods. In this view, by focusing on the short cusps, the latter are found to face all the same way, towards the thick posterior end of the jaw plate.

The radula is very large and dark coloured. It is 22 mm. long and 17 mm. wide, though only 13 mm. wide at the part which is functional. The 40 rows of teeth are much



TEXT-FIG. 10.—*Pleurobranchoides* sp. *a*, Jaw rods in lateral and end views. × 400. *b*, Lateral teeth of the radula. × 150.

curved. The maximum formula of a row is 120.0.120. The centre of the ribbon is naked. The laterals (Text-fig. 10*b*) are all alike, the first 60 increasing in size and strength, the outer 40 decreasing and becoming paler, with thinner and shorter cusps. Finally, the last 20 teeth in the row are curved on the ribbon so that it is almost impossible to make a flat mount of the whole radula without disturbing some of the teeth. The tooth base is narrow and is set almost vertically on the ribbon. There is a blunt, backwardly-directed prong where the cusp leaves the base, and from this a median wing-like strut leaves the base and supports the cusp to its tip, running along its concave surface and gradually narrowing towards the point of the cusp. The cusp is flattened on the convex surface, so that in transverse section it would be triangular. All the laterals are smooth

—that is, they have no denticulations. They resemble very closely those figured in O'Donoghue's *Pleurobranchoides gilchristi*.

The reproductive system is essentially similar to that described by Vayssière in other Pleurobranchids. There is a small compact prostate on the vas deferens, the penis is papillose, but unarmed, and lies in a well-defined sheath. The female duct is large and thick-walled, and receives near its exit an albumen and a mucus gland, while on the opposite side of it lies a spherical spermatheca. There are three apertures into the vestibule, the oviduct, the duct of the albumen and mucus glands and the spermathecal duct. The male and female apertures are close together in a large genital atrium.

There is a very close resemblance between this specimen and that described by O'Donoghue as *Pleurobranchoides gilchristi* from South Africa. Dr. O'Donoghue kindly sent me his two specimens for comparison, together with the radula and jaw plates of one of them. His specimens came from a depth of 340 metres ; the larger was 66 mm. long, or about three-quarters the size of the Aden specimen. The external appearance is very similar, except that the ctenidium of *P. gilchristi* is relatively smaller, but this difference may be due to contraction. The jaws and their rodlets resemble those of the Aden specimen closely. O'Donoghue describes a radula of 34 rows and a formula of 110.0.110, with a naked rachis. The present specimen with its 40 rows and formula of 120.0.120 is built of similar teeth, though the radula as a whole is less highly chitinized, and the rachis does not show the vestigial inner laterals of O'Donoghue's specimen. The differences are, however, slight, and there is little justification for claiming them as specific. No other species of *Pleurobranchoides* is known, but since the Aden specimen is imperfect, it is impossible to assess all its characters, and hence no specific name can be given to it.

Hexabranchus sanguineus (Rüppell & Leuckart). (Text-figs. 11, 12.)

Doris sanguinea, Rüppell & Leuckart, 1828, p. 28.
Hexabranchus faustus, Bergh, S.R., Bd. ii, heft 13, pp. 547–566 ; Hägg, 1904, p. 5 ; Eliot, 1904, p. 270, and 1908, p. 98 ; Vayssière, 1912, p. 16.

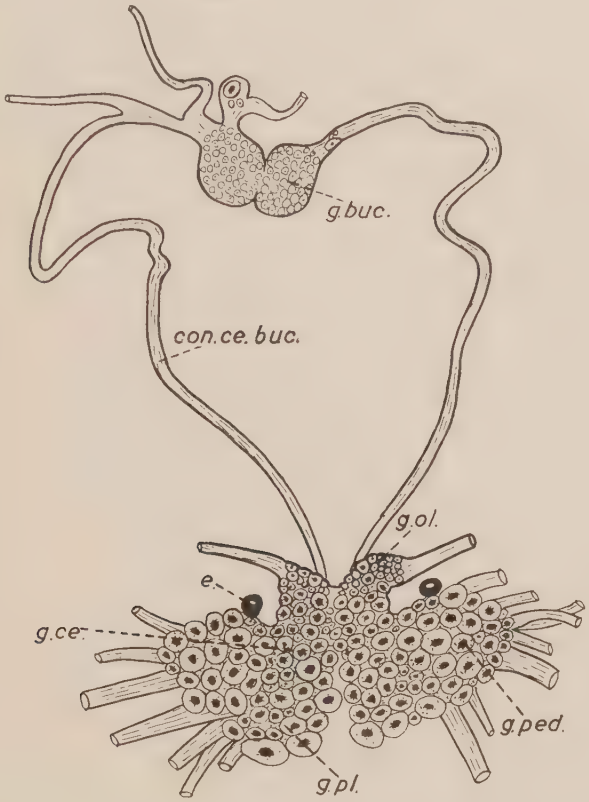
Occurrence.—Sta. 10, Red Sea, near Aden, 17.ix.33, 55 metres ; one specimen, 65 mm. long, 57 mm. broad and 26 mm. high, foot 48 mm. long and 15 mm. broad.

Distribution.—Red Sea, Indian and Pacific Oceans.

Descriptive Notes.—The specimen bore no trace of colour, but Col. Sewell supplied me with a colour sketch which he made from the living animal. This showed that the colour was bright carmine, with a light edge to the mantle, the red alternating with white on the mantle rim. The branchiæ were a paler red, the rhinophores and their sheaths a yellowish orange. The skin is smooth and soft, without tubercles. There is a wide mantle skirt extending all round the body and thinned and frilled on the edge. The body is rather flattened and soft. The rhinophores are protected by a smooth-edged vallum or sheath. They are foliate and widely spaced, being about 21 mm. apart. The branchiæ are in seven bunches, one bunch being smaller than the others. They are trifoliate and are almost but not completely contractile into a cup. The anus is central within the branchial ring, the renal aperture is on the left and there is a small pore on the right. The foot is rather narrow and very tough ; it is much contracted and is thrown into folds. Its anterior border is narrower than the rest of the foot. The mouth is circular, with

large flap-like oral tentacles projecting laterally over the mouth. In contraction these tentacles have a crenated outline. The genital aperture is on the right side.

The jaws are well developed, and consist of numerous rodlets, which are tall and curved. A pair of strap-like salivary glands are present. The radula is very broad, dark-coloured and strong, measuring about 10 mm. in length and breadth. All the teeth are simply hooked. There are 41 rows, with a maximum formula of 65.0.65. The centre of the ribbon is entirely devoid of teeth and is clear. As the rows of teeth are much curved and there is a deep declivity in the middle section of the radula, the inner



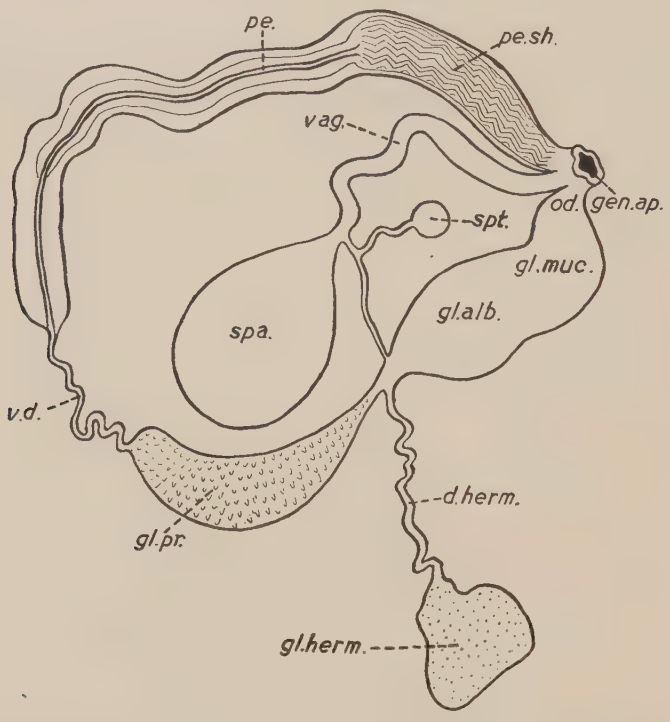
Text-fig. 11.—*Hexabranchus sanguineus*. Nervous system, dorsal view. × 12.

laterals tend to close over the gap. These inner teeth are small, but increase gradually up to the middle of a row, then decrease towards the outer end of the row. The outermost teeth are not, however, degenerate. I have never seen a more worn radula. Some of the teeth have the cusps blunted and very irregularly shortened, others are worn to the base. As the crop was filled with Foraminifera, worm tubes and pieces of Gastropod and Echinoderm shells, the diet is probably the cause of the abrasion. The first lateral is small and may have a cusp or may be imperfect. The cusps of the first 20–25 teeth increase in length, but narrow to fine hooks as their distance from the centre increases. The middle teeth of the row have the largest and strongest cusps, but after this the cusps shorten and become stouter, while the bases of the teeth become progressively smaller. There is an increase also in the obliquity of the base, whereby the cusps, instead of being curved, gradually acquire a straight form and erect position.

The œsophagus enlarges into a voluminous crop, full, as above stated, of animal

remains. The stomach is small, with large bile ducts. The intestine leaves on the left, and bends round dorsalwards and to the right, finally becoming mid-dorsal as it nears the anus.

In the reproductive system (Text-fig. 12) the common hermaphrodite duct has a slight ampulla. It divides into male and female portions, the former passing through a prostate wrapped round the spermatheca, with a very long coiled vas deferens and long penis. The penis sheath is provided with longitudinal chitinous thickenings arranged in zigzag fashion, but there is no armature of spines. The whole is enclosed in a smooth



Text-fig. 12.—*Hexabranchus sanguineus*. Scheme of reproductive system.

sheath. The female duct has rather small albumen and mucus glands and is connected with a spermatheca and spermatocyst, the former with one duct. The usual three apertures into the genital pore are present, viz. male, female and vaginal apertures.

The nervous system (Text-fig. 11) is highly concentrated. A large nerve mass surrounding the œsophagus consists of the cerebral, pleural (pleuro-visceral), pedal and outlying olfactory ganglia, but there is no delimitation of the ganglia, except that it is evident that the cerebral portion is the smallest and the pedal portion the largest. There are sessile eyes on the cerebral ganglia and sessile otocysts on the pedal ganglia. The nerve-cells are so large that the ganglionic mass has a granular appearance to the naked eye. This is characteristic of the genus.

Bergh enumerates five species of *Hexabranchus*, which, though varying in size and colour, have no distinguishable anatomical differences. It is probable, as Eliot suggests, that several at least of Bergh's species are merely colour varieties, for which the old name *H. sanguineus* is most suitable. The above specimen resembles in its coloration *H. faustus* of Bergh (taf. 41, fig. 3).

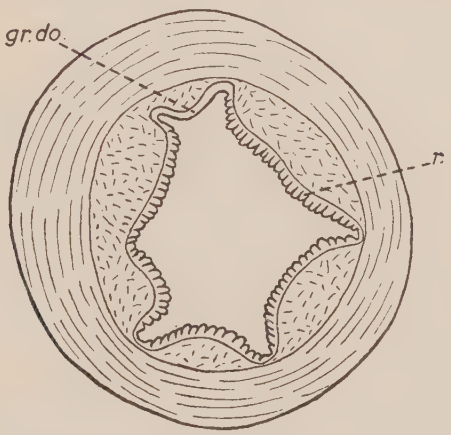
Nembrotha lineolata Bergh. (Text-figs. 13–16 ; Pl. I, fig. 6.)

Nembrotha lineolata, Bergh, Siboga Report, 1905, p. 199 ; Eliot, 1906*a*, p. 669.

Occurrence.—Sta. 45, Indian Ocean, near Kuria Muria Islands, 29.x.33, 40 metres; one specimen, 22 mm. long, 5 mm. wide, 10 mm. high at about the middle of the body.

Distribution.—Indo-Pacific area.

Descriptive Notes.—The specimen is slug-like, with its greatest height in the region of the branchiæ. Its general form resembles that of an *Elysia* rather than that of a member of the Polyceridæ. The head is small, with a narrow mouth aperture overhung by a pair of short puckered oral tentacles, linked together so as to form a kind of oral veil. On the summit of the head lie the pair of relatively large foliate rhinophores, each partly covered by a prepuce-like sheath of unpigmented skin, giving the animal a bespectacled appearance. The mantle is soft, loose and smooth, and since it is continuous with

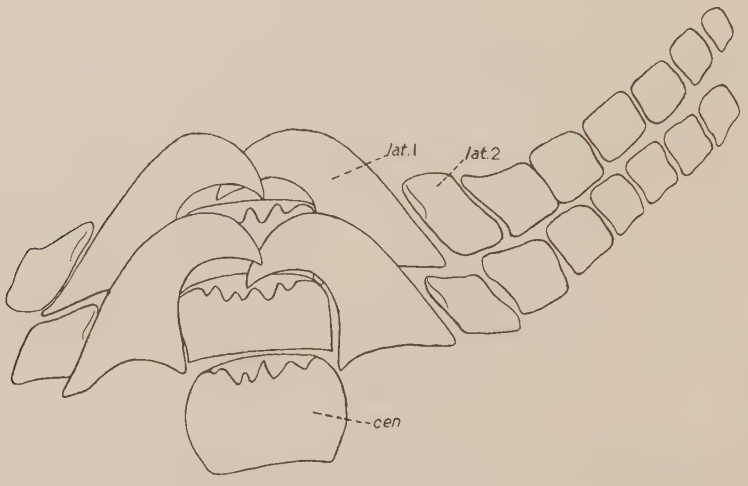


Text-fig. 13.—*Nembrotha lineolata*. Transverse section of the buccal region to show rods. × 112.

the pedal margin there is no mantle rim. About the middle of the body it rises to the elevation bearing the anus and branchiæ ; posterior to this it narrows, with the foot, to form a tail. The anus is mid-dorsal, the genital aperture on the right side just behind the head. The foot is elongated, and in the specimen the lateral margins are approximated. Anteriorly it is truncated, with the corners somewhat prolonged. The branchiæ consist of three ramified stems, but as they have been badly damaged it is impossible to determine their shape. They form a crescent whose opening is posterior, and within the horns of the crescent lies the median anus. The ground-colour of the animal was probably yellow, but is now dirty white, with longitudinal stripes of brown and grey. The stripes do not branch, and rarely unite. They run parallel with one another, and if three stripes converge towards a narrower part of the body, the middle stripe fades out, as in the head and tail regions. A median stripe runs along the back and stops short anteriorly between the rhinophores, while the second lateral stripe is continued forwards ventral to the rhinophores as a broad band, which joins its fellow round the front of the head between the top of the head and the oral lobes. Posteriorly the three middle stripes ascend the branchial stems and fade out at the base of the filaments, commencing again posterior to the branchial region, while the lower stripes are continuous round the base of this area. Posteriorly

the main stripes extend to the tail end. There are no spots or interrupted lines on the body. The oral region and foot are of a faded Prussian blue colour, and the same colour tinges the three groups of branchiæ.

The mouth aperture, which is small and unguarded by jaws, leads by an introvert to the small buccal mass. The introvert is coloured a deep blue and is muscular, but not thick-walled; its lateral borders are almost parallel. A pair of short, branched retractor muscle tendons pass backwards and lateralwards to the body wall. The posterior part of this region forms the buccal mass proper. *Externally* the difference is marked by a change of colour from blue to yellow, and the odontophore shows through its wall as a pair of rounded masses, each with its own branched retractor muscle. *Internally* the limit between introvert and buccal mass is shown by a sudden constriction of the wide cavity, the entrance appearing brown in colour. On removing and mounting this region, the brown colour was seen to be due to a collar (Text-fig. 13) made up of several rows of chitinous rods,



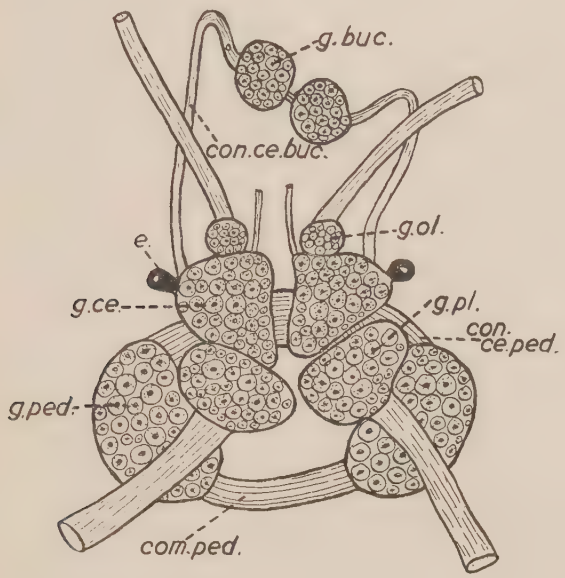
Text-fig. 14.—*Nembrotha lineolata.* Three centrals and part of two rows of lateral teeth. × 200.

similar to the rod cells of the jaws of many Nudibranchs, but less compactly arranged. The collar is broken mid-dorsally. The radula is very small and narrow, and lies on the usual pulley-shaped rotella. It consists of 14 rows of teeth, the maximum number of teeth in any row giving the formula 7.1.1.1.7 (Text-fig. 14). Bergh ('Siboga Reports', 1905, p. 199) described 32–36 rows of teeth in this species. The rachidian tooth lies in a deep groove between the large and strong first laterals, which overlap it. It is colourless and can be of little use, and it is not surprising that in the allied genus *Trevelyana* the central is absent. Its shape is hemispherical, the free edge being slightly recurved, with four blunt denticles, of which the second on one side is bifid, giving a slight asymmetry to the tooth. The first lateral is very large and strongly hooked, with a pointed process on the narrow concave base, so that its shape is somewhat like that of a Cestode hook. The second lateral is trapezoidal, with a slightly elevated cutting edge, but neither cusp nor denticles. The remaining laterals are mere flat tiles on the radular ribbon. They diminish both in size and chitinization as their distance from the rachidian tooth increases.

No salivary glands were found. The œsophagus is thin-walled and passes straight backwards to the visceral mass, which exhibits only hermaphrodite gland on its surface. The liver and stomach are in the centre of the mass, into which the œsophagus plunges.

The stomach is small and receives the bile ducts. From its left border comes off the intestine, which curves forwards, loops round the heart, and passes back along the right side, finally turning dorsalwards to the median anus.

In a single specimen it is difficult to make out all the details of the reproductive system, though the chief portions could be dissected (Text-fig. 16). The hermaphrodite gland forms the rind of the compact ovate visceral mass. The surface is studded with small rosette-shaped areas (*gl. herm.*) composed of a central circular ductule surrounded by from 5–7 smaller, rounded germinal diverticula. The slender common hermaphrodite duct (*d. herm.*) leaves the gland on its right side and passes forwards to the accessory genital complex, which is nearly two-thirds the size of the visceral mass. On entering this region the duct enlarges, forming the ampulla of the hermaphrodite duct (*amp.*).

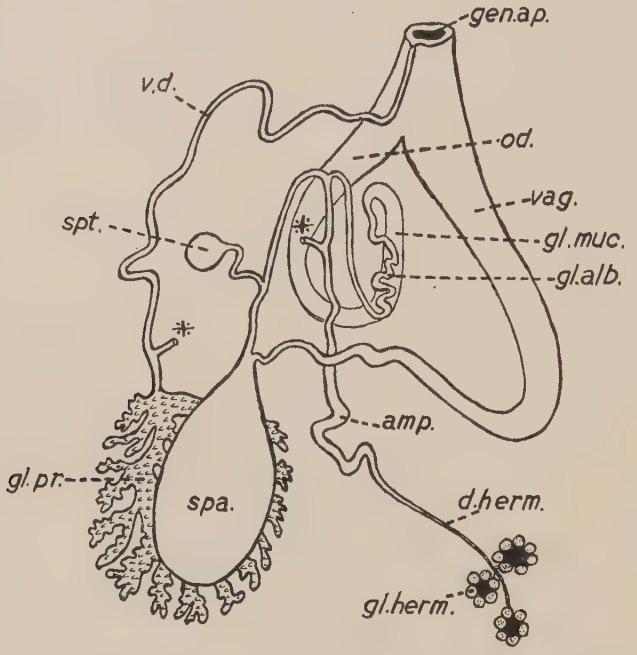


Text-fig. 15.—*Nembrotha lineolata.* Nervous system, dorsal view. × 33.

It then contracts again, separates into male and female portions, the latter dividing at right angles into oviducal and vaginal ducts. The oviduct becomes very much thickened and convoluted. It is at first opaque (albumen gland), then translucent (mucus gland), The walls become muscular as the genital aperture is approached. The vaginal duct turns posteriorly and bears two diverticula. The one nearest to the vaginal aperture is a pear-shaped thin-walled vesicle, the spermatheca (*spa.*), which contains a mass of debris. The other is borne on a short stalk, is spherical and thicker walled and is called the spermatocyst (*spt.*). Wrapped round the spermatheca is a racemose prostate gland (*gl. pr.*), whose duct joins the male duct to form the long coiled vas deferens, which is thick-walled and opens into the common genital atrium. Thiele states that there is no prostate in *Nembrotha*, but this species has a very well-developed one. No penis was present in the specimen, and the details of this part of the apparatus could not therefore be investigated.

The concentrated ganglionic mass surrounding the œsophagus is composed of a pair of triangular compressed cerebral ganglia, ovate pleural (pleurovisceral) and elongated pedal ganglia, the last named being the largest (Text-fig. 15). The cerebro-pleural and

cerebro-pedal connectives are very short, but the pedal commissures are longer owing to the lateral position of these ganglia. Two small olfactory ganglia (*g. ol.*) lie on the anterior face of the cerebral ganglia, and laterally are the small, pigmented and shortly stalked eyes. The buccal ganglia (*g. buc.*) are linked with the cerebrals by means of long connectives ; their commissure, on the other hand, is unusually short. From the pleural ganglia a pair of long broad nerves pass backwards to the branchial region and are connected by a ganglionated cord anterior to the anus.



Text-fig. 16.—*Nembrotha lineolata.* Scheme of reproductive system. The male duct should be continuous between the asterisks.

Glossodoris sp.

Occurrence.—Sta. 45, South Arabian coast, near Kuria Muria Islands, 29.x.33, 40 metres ; one specimen, 13 mm. long, 5 mm. broad. Note 134 states that the specimen was found, with another Dorid, upon or within a large fleshy, much-branched Alcyonacean.

Descriptive Notes.—This specimen has no external surface, except in small areas. The mantle and foot had been stripped off, leaving the rhinophores and branchiæ. The former are of the usual perfoliate type, the latter consist of eleven, small, simply pinnate gills. The buccal mass is large and protruded.

The inner mouth lining is protected by a broad girdle of lip rods, 2 mm. deep. The rods are very regularly arranged in rows, and each of the functional rods is bifid and curved like a radular tooth. The radula is relatively as small as the lip plates are large. It consists of 54 rows, the maximum number of teeth in a row being 46.0.46. There is no central. The first lateral has a single denticle on its mesial face and three denticles laterally. The remainder of the teeth have denticles on their outer edges only, usually from 4–7. The cusp increases slightly in length up to approximately the 12th tooth in the row, then decreases again, the denticles, however, getting longer. The outermost teeth are smaller but not degraded. Owing to the shortening of the cusp and lengthening

of the denticles of these outermost teeth they resemble combs or even forks in some of the rows. The stomach is indistinct and there is a small gall bladder.

The central nervous system shows small cerebral ganglia, widely spaced eyes, large pleural (pleurovisceral) ganglia and rather large ovate pedal ganglia. No outlying olfactory ganglia are visible, but poor preservation may explain this.

In any collection of Nudibranchs from the Indo-Pacific area, it is to be expected that a genus so rich in species as *Glossodoris* would be represented, and it was disappointing to find only one imperfect specimen. The number and simplicity of the branchiæ, the elongated shape, the lip plates of forked rods, and the radula with denticulate lateral teeth but no rachidian tooth are sufficiently diagnostic of the genus *Glossodoris*, but owing to the absence of the outer skin and foot, and the bad preservation of the internal parts, particularly of the genitalia, it is impossible to determine the species.

A Dorid.

Occurrence.—Sta. 45, South Arabian coast, near Kuria Muria Islands, 29.x.33, 40 metres. The specimen is 7 mm. long, 6 mm. broad and 4 mm. high. The foot is 5 mm. × 3 mm.

Descriptive Notes.—The specimen was found upon or within a large fleshy much-branched Alcyonacean.

There is no colour, and the warts of the notum are eroded so that it is difficult to be certain of the appearance of the living animal. The body is soft, broad and plump, much flattened ventrally, of fairly regular elliptical outline. The rhinophores are widely spaced, their sheaths with smooth rims. The branchial pocket is torn, but the edge was probably thrown into folds. The branchiæ are rather large, 5 in number, set very far back on the body, tripinnate. The foot is very broad and flat, not puckered at the edges, broadest anteriorly, with rounded anterior margin, and not, as far as could be seen, bifid. Posteriorly it tapers somewhat, but is rounded and does not project beyond the mantle skirt. The latter is 2 mm. wide on each side. A pair of round oral tentacles curve backwards and lateralwards like ram's horns on the side of the small head.

The interior was too much decomposed to allow of detailed investigation of the organs. The buccal mass is very large and the salivary glands large, irregular, and bent back on themselves. The stomach is well defined and there is a small gall bladder. The whole of the liver and hermaphrodite gland had broken up into small pieces.

The lips have a chitinous cuticle but no lip plates. The radula has 26 rows of teeth, with a maximum formula of 36.0.36. The innermost laterals are not particularly small or sunk, as in some genera, nor do they disappear in the older rows. There is a slight but gradual increase in size in the teeth up to about the 30th tooth in the row, then a small decrease, and the last four or five teeth are degraded, with fringed edges. The functional teeth are simply hooked, are set on narrow bases, but have a hump on the back of the tooth where the cusp arises from the base.

The reproductive system could not be fully investigated. The female duct has the usual albumen and mucus glands, and is unarmed. No prostate was found and no armature on the male duct. A large spermatheca and pear-shaped spermatocyst are present.

The nervous system is small, flattened and concentrated, though the component

ganglia are distinct. It resembles that of *Discodoris*. Olfactory ganglia are present and the eyes are widely spaced. The pedal ganglia are lateral and the pedal commissure is short.

The specimen may be a species of *Trippa*, but the small size, bad preservation and absence of the lower portion of the genital duct make identification difficult.

Discodoris sp.

Cf. Bergh, S.R., 1876–8, p. 519 ; 1884–92, p. 897 ; Eliot, 1903*b*, p. 364.

Occurrence.—Sta. MB II (*c*), South Arabian coast, 28.x.33, 30 metres ; one specimen, 7 mm. long, 4·5 mm. broad, 3 mm. high.

Descriptive Notes.—The body is broadly ovate, slightly broader anteriorly. The notum is covered all over with small papillæ like down. There are remains of a few spots laterally and the branchiæ are dull brown, otherwise the specimen is colourless. The skin is loaded with rod-like spicules. The rhinophores are retracted into cups, whose rims, flush with the surface, are papillose. The branchial aperture is similar, and there are six branchiæ, contracted but not withdrawn into the cup. The head is retracted into a kind of nuchal pocket under the mantle, and bears a pair of small finger-like tentacles. The mantle skirt is 1·5 mm. wide, the foot long and narrow, projecting posteriorly beyond the mantle as a tail. It is 5 mm. long and 1 mm. wide, its anterior border bifid.

The lips appeared to be unarmed, but on mounting the skin lining the anterior portion of the cavity of the buccal mass a pair of small irregular jaw plates were found, whose rodlets are short, compact and blunt. The radula consists of 42 rows, with a maximum formula of about 63.0.63, but the teeth are so small and close together that it is difficult to count them. There is no rachidian tooth. All the laterals are hooked and have smooth edges. The innermost are broad and shortly hooked, the outermost very long and slender, and hardly hooked at all but merely curved slightly. The remainder of the gut was badly preserved.

There is no armature on the genital apparatus. It is impossible to determine the species of this single and very small specimen. It agrees fairly closely with Bergh's *D. boholiensis* in the number of rows in the radula, the number of teeth in a row and in the attenuated nature of the lateralmost teeth.

Halgerda willeyi Eliot. (Text-figs. 17, 18 ; Pl. I, fig. 3.)

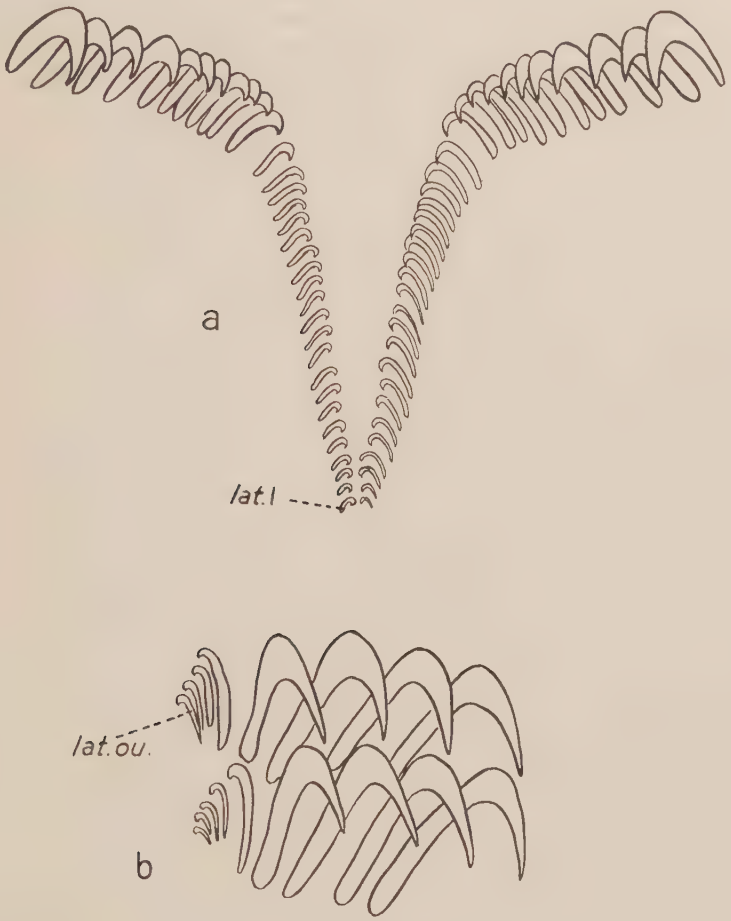
Halgerda willeyi, Eliot, 1903*b*, p. 372, pl. xxxii, fig. 5 ; Vayssière, 1912, p. 40, pl. i, fig. 7.

Occurrence.—Sta. 45, South Arabian coast, near Kuria Muria Islands, 29.x.33, 40 metres ; one specimen, 20 mm. long, 14 mm. broad, 10 mm. high ; foot 15 mm. long, 3 mm. broad.

Distribution.—Red Sea and Indian Ocean.

Descriptive Notes.—Only black and white colouring is present, the yellow mentioned by Vayssière having left no trace. The shape is broadly ovate, the mantle skirt projecting well beyond the foot on all sides. The notum has black streak-like markings. Some of these are branched and run at right angles to the mantle edge. Others, rarely branched, are longitudinal and run along the middle of the back. Tubercles are present and there is a dorsal keel. The anterior tubercles are median ; the posterior ones

form a circlet around the branchial region, but some distance from it. The tubercles are connected by ridges which give the appearance of a reticulum. The markings on the mantle edge are visible on its underside and the edge of the foot has a similar pattern. There are only two bunches of gills, much branched and striped with black. The anus projects on a tube with crenated aperture between the gills. The head bears very small button-like oral tentacles, and completely retracted, lamellate rhinophores. The mouth aperture is circular, corrugated owing to folds, and marked with black spots. The anterior

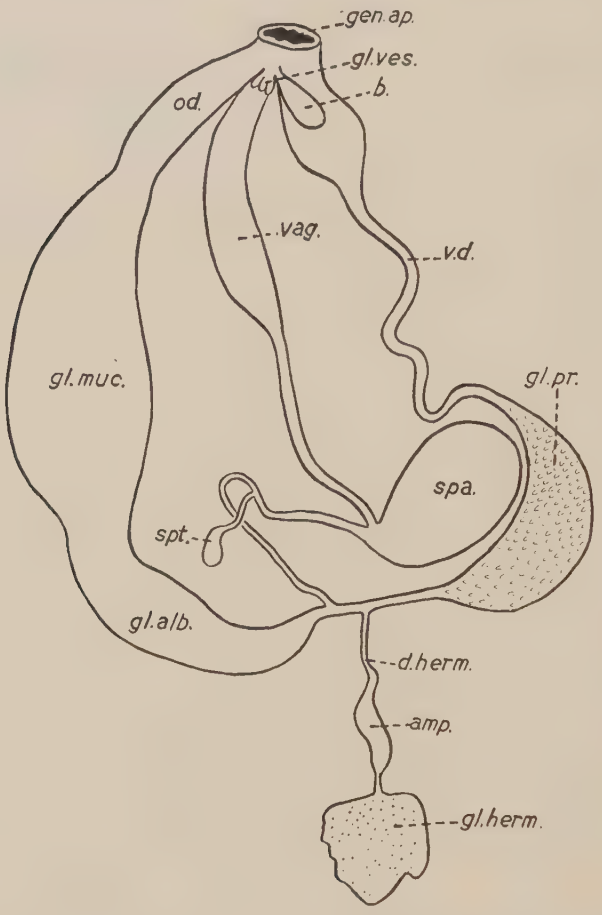


Text-fig. 17.—*Halgerda willeyi*. *a*, Inner lateral teeth to show median groove in the row. × 54. *b*, Outermost laterals. × 126.

margin of the foot has two lips. The skin of the notum is soft except on the tubercles, but no spicules were found.

The buccal mass is without jaws, though there is a thin, pale, smooth chitinous lining to its anterior portion. The radula (Text-fig. 17) is well developed, and measures 8 mm. long and 4 mm. wide in the functional portion. The radular sac protrudes from the ventral side of the buccal mass as a rounded knob. There are 50 rows of brown teeth, with a maximum formula of 52.0.52. The ribbon appears narrow, but when extracted is found to be of considerable width owing to the depth of the central groove (Text-fig. 17*a*), and to the curvature downwards of the outer edges. Since the teeth in the groove and on the recurved edge are much paler than those on the flattened part of the radula, it is

reasonable to assume that the dark brown teeth of the flattened area are those most used. There is no central. The first 20 laterals of each side in one of the broadest rows lie within the groove; then come about 28 teeth on the flattened cutting surface, and the last three or four teeth in the row are on the recurved portion of the ribbon. The teeth of the first group are small but well developed, with short, distinct, smooth cusps curved towards the centre. Their bases are narrow and rather shapeless. Although the cusps get longer, stronger and more deeply coloured as the distance from the centre increases, there is



TEXT-FIG. 18.—*Halgerda willeyi*. Scheme of reproductive apparatus.

nevertheless an abrupt change between the 20th and 21st tooth, *i. e.* at the point where the groove becomes flattened out. The cusps remain simple, but the bases become stronger and more and more oblique. Finally the outermost three or four teeth (Text-fig. 17*b*) show decreasingly smaller bases and cusps, and remind one of the vestigial marginal teeth of a *Patella*. It is characteristic of the teeth in *Halgerda* that the whole of the base curves over into the cusp, and that there is no shoulder or prolongation of the base anterior to the cusp (cf. *Asteronotus*, p. 104).

The hermaphrodite gland lies on the liver (see Text-fig. 18). Its duct has an ampulla (*amp.*), and divides into male and female portions. The vas deferens (*v. d.*) passes through a large prostate (*gl. pr.*), which is wrapped round the spermatheca (*spa.*). The narrowed sinuous portion of the duct becomes greatly enlarged near the male aperture, and this

region is provided with a muscular bulb (*b.*). No stylet could be found. The female duct receives a fertilizing duct from the seminal receptacles, and then enlarges as it passes through albumen and mucus glands, which are entwined to form the usual accessory genital complex. The female aperture is large and muscular. The third aperture into the genital atrium, that of the vagina (*vag.*), leads direct to a large pear-shaped spermatheca, whose second duct is connected with a globular spermatocyst communicating with the fertilization chamber by a slender duct. Bean-shaped vestibular glands (*gl. ves.*) encircle the vaginal aperture. The important points for classificatory purposes are the presence of a well-defined prostate, the bulb on the unarmed penis and two ducts to the spermatheca.

Halgerda apiculata (Alder & Hancock).

Doris apiculata, Alder & Hancock, 1864, p. 122, pl. xxx, fig. 8.
Halgerda punctata, Farran, 1905, p. 339.
Halgerda apiculata, Eliot, 1906*a*, p. 1002 ; Vayssière, 1912, p. 38 ; O'Donoghue, 1932, p. 155.

Occurrence.—Sta. 10, Red Sea near Perim, 17.ix.33, 55 metres ; one specimen, 30 mm. long, 23 mm. broad, 11 mm. high. Foot 20 mm. long, 3·5 mm. broad.

Distribution.—Red Sea and Indian Ocean.

Descriptive Notes.—There is no trace of colour. The notum is strongly tuberculate, with keeled elevations between the smoothly rounded tubercles and soft smooth areas between the keels. There is a strong mesial keel commencing 4 mm. from the anterior end and ascending over the dome-shaped back, stopping short and bifurcating in front of the branchial cup. Lateral elevations cut off two pairs of areas enclosed by tubercles on the summit of the back, and there are imperfect ones anterior and posterior to them. From these four completely or partially enclosed areas rows of smaller tubercles run out towards the thin smooth edge of the mantle skirt. Here the tubercles are closer together, smaller and not always linked by keels. Other radiating rows of tubercles fill up the gaps between the main lines. No trace of rhinophores could be found externally, so completely were they retracted. The branchial cup is also strongly contracted and stands up like a spout in the middle line posteriorly, so that it looks like one of the tubercles. On slitting it up, however, it is seen to lead to an expanded chamber bearing on its floor a pair of contracted black-spotted branchiæ, each branched into three. Between the branchiæ lies the anus, on the summit of a tube whose border is crenated. The lining of the cup is also pigmented in the form of spots. The foot is extremely narrow, even allowing for its contraction. Anteriorly it has a bifid border, cleft mesially. Posteriorly it is prolonged into a tail. The head is very small, and is completely hidden under the forward projection of the mantle slit. In the specimen it is shut in by an ogee-shaped fold which fades out on either side of the foot. The mouth is hidden and is very small. The foot projects forwards, thus pushing aside the small, simple, oral tentacles, which are here contracted to mere knobs.

Internally the connective tissue covering the dorsal body organs is pigmented, but there is no pigment ventrally. The buccal mass is well developed, with strong tendons mooring it to the sides of the body wall. A flat chitinous plate, without rod cells, lies at the entrance to that portion of the buccal mass containing the odontophore. The radula has 55 rows, with a maximum formula of 65.0.65. The general arrangement is similar to that described in *H. willeyi* (*vide supra*, p. 101), but there is a more gradual change between

the functional teeth on the flat part of the ribbon and those lying in the central groove. The latter slope sideways and mesialwards; the former are almost vertical, the cusps of one row usually alternating with and overlapping those of the next row. The last four or five teeth in a row are smaller, curve inwards and tend to become split and degenerate, but they can hardly be described as denticulate. The œsophagus is short, passes to the left, and leads to a thin-walled stomach cavity, containing white amorphous matter. It receives a single bile duct ventrally. The intestine leaves on the right side, close to the entrance of the œsophagus, so that the stomach has a blind posterior end. The intestine curves backwards on the right side towards the anus. No salivary glands could be found in the specimen; Bergh describes them as long and thin, no thicker than nerves, in an allied species.

The reproductive organs are similar to those of *H. willeyi*, but the ducts are much shorter. The penis bulb is pigmented, but not armed.

Asteronotus hemprichii Ehrenberg. (Text-figs. 19, 20.)

Asteronotus hemprichii, Ehrenberg, 1831, p. 97; Bergh, 1877, pp. 161–173; Eliot, 1903*b*, p. 384, pl. xxxiv, figs. 5, 6; *id.*, 1908, p. 116.

Occurrence.—Sta. 27, Gulf of Aden, near Cape Guardafui, 12.x.33, 26–91 metres; one specimen, 32 mm. long, 23 mm. broad, 10 mm. high.

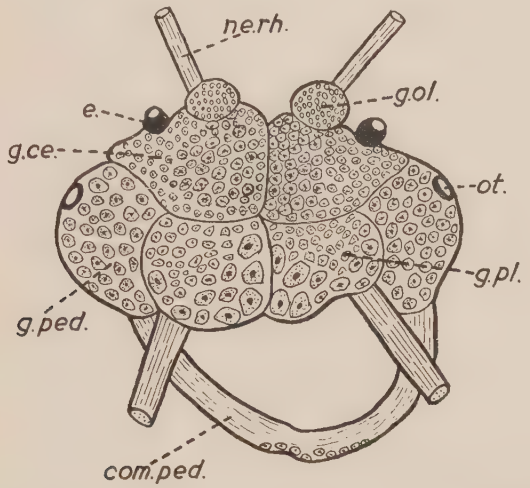
Distribution.—Indian and Pacific Oceans.

Descriptive Notes.—Without colour except for a few brown spots. The notum is very broad, giving an ovate outline. It overhangs the head and foot, is broadest posteriorly and tapers to a point anteriorly. The dorsal surface is covered all over with papillæ, with radiating and anastomozing areas formed by raised ridges, bearing a few knob-like excrescences. It is full of spicules. The mantle skirt is very wide and thin, extending 10 mm. beyond the foot on all sides except anteriorly. Its underside is spotted with brown and covered with a fibrous-looking radiating pattern. The rhinophores are completely retractile into cups with lobed edges, the right aperture having nine lobes. The branchial region is also much contracted, with a small, eight-lobed aperture leading to the gill chamber. There appear to be seven gill plumes united by webbing, but owing to contraction, it is difficult to be certain of this. The foot is only 19 mm. long and 5 mm. wide, much contracted and puckered along the edge. The anterior margin is two-lipped, the anterior lip cleft mesially. The head is very small, with a pair of oral tentacles contracted to small lateral knobs.

The lining of the small mouth aperture is thrown into numerous folds. The anterior portion of the buccal mass was evidently capable of considerable extension, as it is folded both longitudinally and transversely, and is supplied with from 6–8 strong flat tendons. There is no trace of mouth armature. The radular sac projects ventro-laterally from the buccal mass towards the left, the right side being occupied by the genital complex. The radula has 45 rows, with a maximum formula of 53.0.53. The first row has ten teeth on one side and fourteen on the other. All the teeth are simply hooked. The last three or four teeth in a row are small and degenerate. It is characteristic of the teeth that the base projects forwards as a kind of hook or shoulder, so that the cusp is not terminal on the base. A pair of short, stout, recurved salivary glands lie on either side of the œsophageal region on the dorsal side of the buccal mass, their ducts opening in the usual

position. The œsophagus is short, and runs along the mid-ventral side of the lenticular stomach. The duct of the digestive gland is very large and is provided with a small globular gall bladder. Like the œsophagus, it is connected with the ventral wall of the stomach. The intestine leaves dorsally and from the right side, curves lateralwards and then posteriorly to ascend to the anus.

The hermaphrodite gland is embedded in the liver on its dorsal side. The duct is at first slender, then enlarges to form an ampulla, and contracts again suddenly before splitting into male and female portions (see Text-fig. 20). The male duct at once enlarges to form a prostatic enlargement, which is partly creamy white and partly vesicular and surrounds the spermatheca. The vas deferens, at first sinuous, finally runs straight towards the male aperture; it is unarmed. The female duct is provided with a much convoluted albumen and simple mucus gland. The vagina, which is long, has vaginal



Text-fig. 19.—*Asteronotus hemprichii*. Nervous system, dorsal view. × 36.

glands near its aperture and is no wider than the vas deferens. It is connected with a large globular spermatheca, and, by a separate duct, with the fertilization chamber. The latter duct has a stalked pear-shaped spermatocyst opening into it. No trace of a stylet gland or stylet could be found, though Bergh described these. It is quite common for the genital atrium to be damaged in Nudibranchs, and with only one small specimen at my disposal, no means of verifying Bergh's statement are possible.

In the nerve ring (Text-fig. 19) the ganglia are contiguous, but their outlines are distinct. The eyes are sessile and there are large olfactory ganglia. The pedal commissure is very broad.

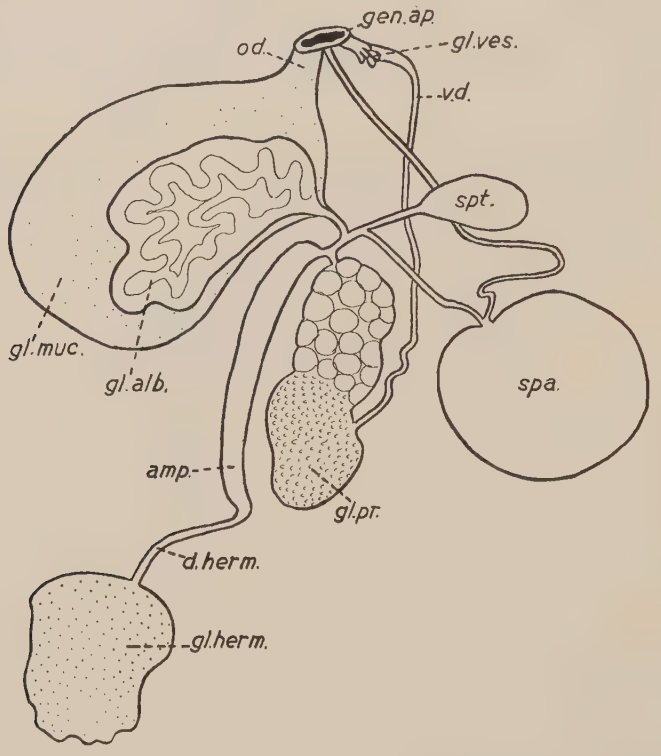
Asteronotus sp.

Cf. Asteronotus madrasensis, O'Donoghue, 1932, p. 158.

Occurrence.—Sta. 43. South Arabian Coast, near Kuria Muria Islands, 28.x.33, 83 metres; one specimen, immature, 16 mm. long, 14 mm. broad, 6 mm. high.

Descriptive Notes.—Buff coloured, with very irregular brown markings and blotches, largest laterally, the central part of the notum being almost clear. There are a few brown blotches on the underside of the mantle, but none on the foot. The general form is ovate,

with a somewhat frilled edge to the mantle. The body is soft but firm, rather high in the middle. It is covered with fine short papillæ and is marked by a radiating network both above and below. The mantle skirt is very wide, being 6 mm. laterally, but a little less anteriorly and posteriorly. The foot is narrow, and measures 11 mm. in length and only 4 mm. in breadth. Its anterior margin is bifid, the front lip split in the middle line. A short tail is present but is not visible dorsally. The lateral border of the foot is puckered, indicating that it is much contracted. The oral tentacles are short and tapering, the rhinophores completely retracted, with a toothed sheath margin. The branchiæ are partly retracted within the transversely ovate aperture, and consist of six much branched structures spotted with brown. The two anterior branchiæ are larger than the others.



Text-fig. 20.—*Asteronotus hemprichii.* Scheme of reproductive apparatus.

The buccal mass is well developed. There is no mouth armature. The radula consists of 56 rows, with a maximum formula of 72.0.72. The teeth bear simple hooks, and there is a projection or shoulder on the base, so that the cusp is not terminal, and the shoulder lies on the convex side of the tooth. At the end of each row are three or four degenerate teeth, much smaller than the rest. On the whole the teeth resemble those of *A. hemprichii* but are more numerous. A pair of thin salivary glands open into the buccal cavity in the usual position. The œsophagus expands into a stomach situated on the left side of the body, and outside the liver. A large bile duct enters the right side of the stomach. The intestine leaves posteriorly, bends to the left, then forwards and to the right, crossing the middle line dorsally. The rectum passes down the right side and ascends to the mid-dorsal anus.

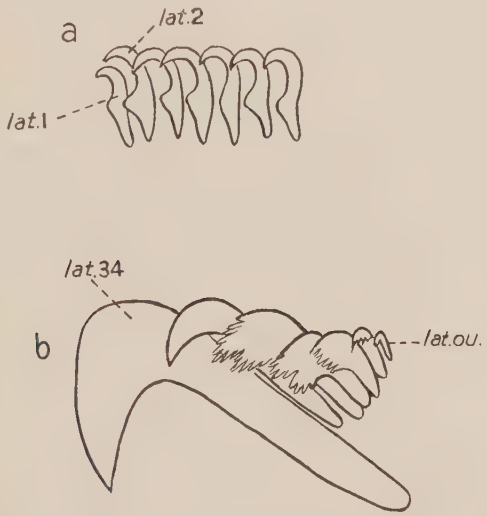
The genital complex is immature and appears to resemble that of *A. hemprichii.* A similar division of the prostate into two parts occurs. The nervous system is also like

that of *A. hemprichii*, *i. e.* it shows contiguity but not fusion of the three pairs of ganglia, and the commissures and connectives are not distinguishable. There are similarities between this specimen and O'Donoghue's *A. madrasensis*, but owing to its small size and immaturity no attempt has been made to give it a specific name.

Artachœa intermedia sp. nov. (Text-figs. 21–23 ; Pl. I, fig. 1.)

Occurrence.—Sta. 27, Gulf of Aden, 12.x.33, 30–70 metres ; two specimens, one much darker than the other, the larger 27 mm. long, 20 mm. wide and 8 mm. high (see Pl. I, fig. 1 *a* and *b*). The contracted foot measures 14 mm. long and 2 mm. broad.

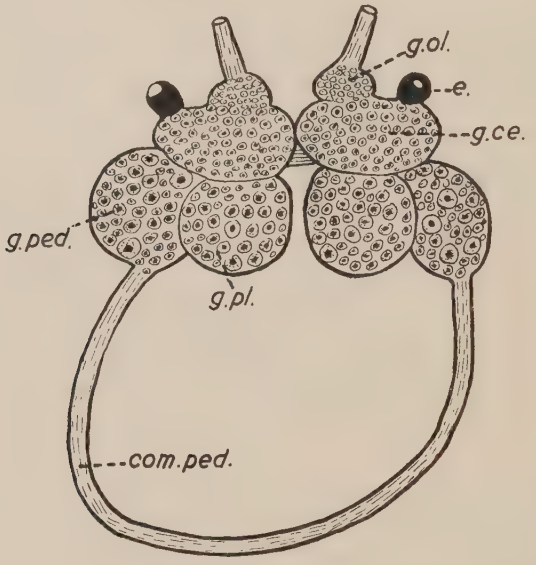
Descriptive Notes.—The animal is fairly soft, and of broad, elliptical shape, with very small rhinophores and branchiæ. The notum is dark brown and mottled, but not definitely spotted, and is covered with scattered warts of varying sizes, but all small.



Text-fig. 21.—*Artachœa intermedia*. *a*, Seven inner lateral radular teeth. × 270. *b*, Seven outermost laterals. × 270.

The warts are centres of radiating star-like patterns, and are obviously much flattened. In the lighter specimen some of the warts have orange-coloured filamentous tags projecting from them, as though the warts were merely the bases for softer papillæ. The edge of the notum has fine warts, which give it a corrugated appearance. The mid-dorsal warts form a faintly marked keel. One specimen is flat, but the other is rolled up almost into a ball. The rhinophore sheaths have papillose rims and are so greatly contracted that they appear no larger than the warts. The branchial aperture is also very small and is papillose. The branchial chamber has six tripinnate, much-branched gills. The mantle has a very broad overhang of nearly 10 mm. laterally, and 4 mm. anteriorly and posteriorly. The foot is therefore very narrow, being barely 2 mm. wide in one specimen, although obviously in a much contracted condition. Anteriorly the foot shows a puckered bifid border and completely hides the mouth aperture. Posteriorly there is a short tail free from the body, but not visible dorsally. The ventral side of the mantle is spotted irregularly with dark brown blotches ; it is quite smooth, but shows the star-like pattern of the notum. A few of the smaller spots extend to the edges of the foot. The head bears a pair of small, flat, oral tentacles.

There is a chitinous mouth lining but no buccal armature. There are 34 tooth rows, with a maximum formula of 40.0.40 (see Text-fig. 21). The radula resembles that of *Halgerda* in the shape of the tooth rows, *i. e.* the functional part of the radula is not the central part, since the latter is sunk in a groove. This central part bears small lateral teeth, the two halves of a row being bent backwards in a V-shape. In older parts of the radula some of these teeth disappear, leaving a naked area. The teeth increase gradually in size towards the edge of the sunk area; then an abrupt enlargement occurs on the flat portion of the radula. Here again the increase in size is gradual, the largest tooth being the 34th lateral (Text-fig. 21*b*). The 35th tooth is smaller but similar, while the last five teeth in the row are close together and vestigial, with fringed edges and a short cusp. All the teeth except the degraded ones are simply hooked. Many have an expansion of the base on the *concave* side of the tooth, like the guard on the hook of a tapeworm, but this disappears on the larger teeth, whose bases are long and narrow.



TEXT-FIG. 22.—*Artachœa intermedia*. Nervous system, dorsal view. × 22.

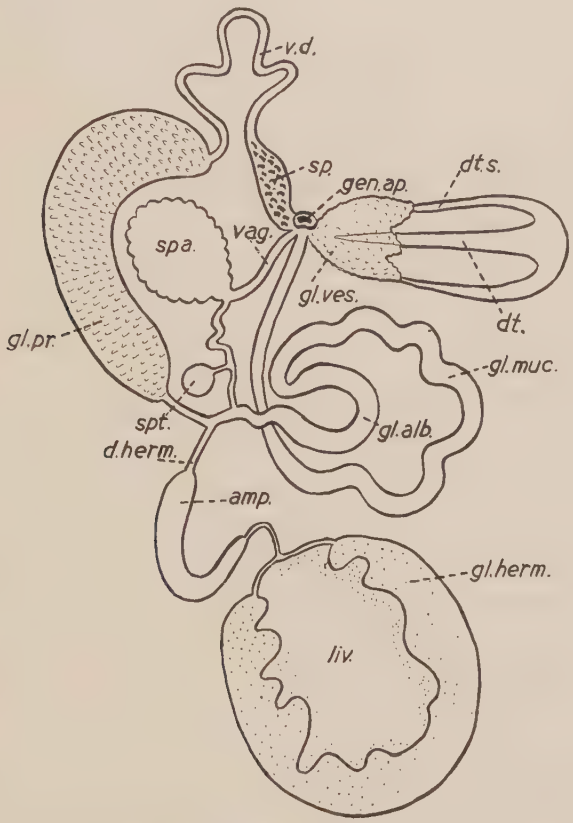
The gut has an enlarged œsophagus with thin walls; the stomach is small and is embedded in the liver. There is a gall gladder. The liver is entirely hidden in dorsal view by a thin layer of gonad. Ventrally the gonad forms a peripheral strip, the centre only being occupied by liver tissue. The intestine leaves the right side of the stomach as usual and passes straight backwards to the dorsal anus.

The hermaphrodite gland occupies, as above stated, the whole of the dorsal and the peripheral portion of the ventral side of the visceral mass (Text-fig. 23). A pair of ducts unite at right angles to form the hermaphrodite duct, which enlarges to form an ampulla bent in a U shape. After contracting again this duct divides into two, a male and female portion respectively. The male portion passes through a large creamy white prostate, which is wrapped round the spermatheca. The sinuous vas deferens (*v. d.*) passes into an armed penis (*sp.*) in one of the specimens, but in the other this armature could not be found. There are numerous rows of curved hooks. The female duct is short, and has the usual albumen and mucus glands along its course. The vagina was unfortunately torn in one specimen, but its opening into the genital atrium had an irregular gland

(*gl. ves.*) close to it, surrounding a club-shaped muscular dart sac (*dt. s.*) containing a flexible horny dart. Spermatheca and spermatocyst are present. The nervous system (Text-fig. 22) exhibits contiguity but not confluence of the ganglia of the nerve ring. The olfactory ganglia are relatively large, and the pedal commissure is longer than in most Dorids.

The two specimens agree in their anatomy and probably belong to the same species. They differ, however, from the recorded species of *Artachæa*, of which those known to me are :

A. rubida Bergh (1880–81, p. 231).
A. clavata Eliot (1907, p. 81, and 1908, p. 116).
A. verrucosa Eliot.



Text-fig. 23.—*Artachæa intermedia*. Scheme of reproductive apparatus.

It is possible, but not likely, that Eliot's second species is a variety of Bergh's *A. rubida*. Its first lateral teeth were denticulate on both sides, and the outermost ten teeth (Nos. 31–40) also bore denticles. There was no trace of labial armature and six small branchiæ were present. Bergh's *A. rubida* had eight branchiæ, a rather broad foot and a radular formula of 31 × 47.0.47, the last four teeth smooth, and from the 13th to the 43rd on each side denticulate along one side. The penis had five longitudinal rows of hooks. He did not mention a prostate on the male duct, but only a soft prostatic portion of the vas deferens. Eliot described *A. clavata* twice. In 1907 he gave a detailed description of a recognizable species from Zanzibar, which he says was hard and harsh to the touch, with eight branchiæ, a weak labial armature and a radula of very numerous

denticulate teeth (120–150 laterals). In 1908 he described a specimen from the Red Sea which had chocolate blotches under the mantle and did not resemble the Zanzibar specimen superficially, but was more like Bergh's *Phialodoris podotria* (1890, pl. lxxxv, fig. 5). It had a labial armature and a radular formula of 50.0.50 in 20 rows. He mentioned also the reticulate pattern between the warts and said it had large rhinophores and branchiæ. It is probable that the Zanzibar and Red Sea specimens belonged to different species, but there is not sufficient evidence to show whether the second is the same as that now described from the John Murray Collection. I suspect that it may be, despite the absence of labial armature, which at its best is vestigial in the genus. The present species seems to form a link between *A. rubida* Bergh and *A. clavata* Eliot, and it is proposed to name it *Artachœa intermedia*.

Thus, *A. rubida* has a soft body, eight branchiæ, unarmed lips, a radular formula of 31 × 47.0.47, the last four teeth smooth, the middle teeth of the row denticulate along one side and increasing in size for two-thirds of the row, the penis with five longitudinal rows of hooks.

A. intermedia has a soft body, six branchiæ, unarmed lips, a radular formula of 42 × 40.0.40, teeth smooth, increasing in size up to the last four or five degraded ones, penis with numerous small hooks.

A. clavata has a hard, harsh body, eight or nine branchiæ, lips with weak armature, radular formula of 35 × 150.0.150, the teeth denticulate and increasing in size up to the last two or three degraded ones, the penis armed with thick-set spines.

In addition it may be remarked that *A. intermedia* has a dark brown, mottled notum, covered with scattered warts which are centres of radiating groups of spicules. The rhinophores and branchiæ are small, the mantle skirt broad, flecked with chocolate brown on the underside, and exhibiting a star-shaped pattern similar to that of the notum. Foot narrow, with bifid anterior border and short tail. Two flat oral tentacles. Genitalia as in other species of the genus, viz. male duct with large prostate, vagina unarmed, but having near the aperture a vestibular gland and a dart sac containing a horny dart. Spermatheca with two ducts, and spermatocyst present. Female duct unarmed, with large albumen and mucus glands.

Phyllidiella pustulosa (Cuvier). (Pl. I, fig. 4.)

Phyllidia pustulosa, Cuvier, 1817, Mem. 8.
Phyllidiella pustulosa, Bergh, 1869*a*, pp. 455, 510; *id.*, S.R., 1876–8, p. 382; Eliot, 1904*c*, p. 283.

Occurrence.—Sta. MB I (*b*), Bay between Great Hanish and Suyul Hanish Islands, Red Sea, 17.ix.33, 29 metres; one specimen, 20 mm. long, 13 mm. wide.

Distribution.—Indian and Pacific Oceans.

Descriptive Notes.—The specimen had preserved its dense black ground-colour and white tubercles surrounded by a white halo. There is a median row of tubercles with elongated halos along the keel of the back, the halos of the last two tubercles being confluent. Laterally a row of three tubercles occur, and at the sides of the notum the white area surrounding a tubercle runs down the edge and may enclose several smaller tubercles, the effect in this region being of alternate black and white stripes, as if the black colour had run down the sides. Beneath the mantle rim lie the gill lamellæ, which are grey triangular plates regularly and transversely arranged on each side of the body between

the mantle and the foot. There are about 80 lamellæ on each side, large ones alternating with smaller lamellæ. The foot is white, with grey sides and a trace of grey on the pedal sole, but otherwise not marked. It is about 16 mm. long and 6 mm. wide. There is no visible trace of rhinophores or anus ; in fact, it is hardly possible to detect which is the anterior end of the animal from the dorsal side. The head is small and is almost hidden by the pedal sole, which projects forwards. It bears two short white oral tentacles overhanging the minute oral aperture. The genital aperture breaks the line of gill lamellæ on the right side, lying between the 13th and the 14th lamellæ.

The mouth leads to a frilled buccal mass, without pigment, and devoid of either jaws or radula. It is held in place by a pair of strong retractor muscles diverging towards the mantle posteriorly, and anteriorly by four small strands attached to the mouth aperture. A short, thick-walled and looped œsophagus passes through the nerve ring and bends towards the left side. A constriction occurs, marked by the presence of four small diverticula, just anterior to the nerve ring. Posterior to the ring the œsophagus again enlarges and becomes suddenly thin-walled. It receives numerous ducts from the voluminous compact liver. This thin-walled region represents the stomach. The intestine, also thin-walled, emerges on the dorsal side of the liver and passes straight back to the posterior anus, acquiring a slightly more muscular wall close to the aperture, where there is an offshoot or rectal cæcum.

Unfortunately the penis was not present and it was not possible to determine whether it was armed. The details of the reproductive system could not be investigated owing to imperfect preservation.

The external characters of this species are easy of identification, but internally the differences between allied species are slight. In the absence of hard parts such as jaws and radula, therefore, the soft parts have been used as criteria. Bergh and Eliot (1904) describe *P. pustulosa* as a species with asymmetrical buccal mass (Bergh) and posteriorly pigmented buccal mass (Eliot). It is probable that both characters are variable ; the present specimen exhibits neither.

Dermatobranchus striatus v. Hasselt. (Text-fig. 24 ; Pl. I, fig. 7.)

Dermatobranchus striatus, v. Hasselt, 1824, p. 242.
Pleuroleura striata, Bergh, 1905, p. 209 ; Eliot, 1906*b*, pp. 566–567.

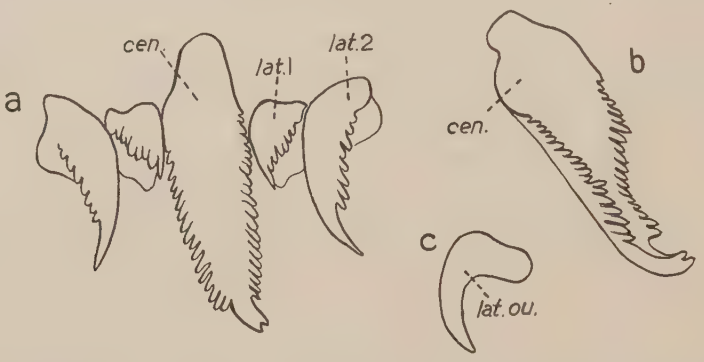
Occurrence.—Sta. 9, Red Sea, near Perim, 17.ix.33, 54 metres ; one specimen, 29 mm. long, 9 mm. broad, 5 mm. high.

Distribution.—Red Sea and Indian Ocean.

Descriptive Notes.—The body is more slug-like than in the genus *Armina*, being broadest near the head and tapering to a narrow posterior end. The foot is narrow, rounded anteriorly, and finely pointed posteriorly. The oral shield is rather broad and rounded, and shows no sign of tentacle formation in the specimen. The notum is broader than the foot and overhangs the body laterally. Anteriorly the edge is broken for the rhinophores ; it curves inwards and backwards towards the latter, and can be described as emarginate. Between the rhinophores the notum is prolonged forwards on the neck so that there is no separation between it and the head mesially. Each rhinophore is contracted and lies in a pit. The pattern on the notum is very distinct. It consists of parallel ridges very regularly arranged, and unbranched. Mesial ridges start between

the rhinophores, run backwards on the summit of the back, then diverge towards the lateral edges of the notum. Other ridges, evenly spaced, commence posterior and lateral to the rhinophores and take a similar diverging course. Near the edge smaller ridges fill up the increasing gaps between the primary ones. The colour has disappeared from the specimen, but there is evidence that yellow and black or grey were predominant, and also that possibly spots were present, but the colouring is not as well marked as in *Armina*. There is no trace of tubercles. The border of the notum contains nettle capsules. There are no gills or lateral lamellæ. On the right side, between the notum and the foot, the genital, renal and anal apertures are visible.

The specimen was opened from the ventral side and the gut was injected. The buccal mass is large, ovate, and measures 5 mm. by 4 mm. It expands almost at once into a large baggy stomach whose diverticulum extends to the posterior end of the body. This and the stomach receive the bile ducts, as in *Armina*, ten from the left and eight from the right side. In addition, there are smaller ducts entering ventrally from the foot.



Text-fig. 24.—*Dermatobranchus striatus*. *a*, Central and two laterals on each side. × 270. *b*, Central from underside. × 270. *c*, Outermost lateral. × 270.

These are irregularly paired and consist of about 8 or 9 pairs. The first bile duct of the right side, representing the right liver, enters asymmetrically at about the level of the genital opening, the bile duct being dorsal to the genital complex. A short distance behind this, the first duct of the left side enters. This portion of the stomach is thin-walled and its lining is not folded. On its left side lies the exit for the intestine, and there is an abrupt change in the lining, which, starting with a sphincter-like fold, becomes furrowed in all directions, though remaining comparatively thin-walled. The stomach diverticulum tapers with the tapering body, its folds gradually arrange themselves longitudinally, and all the remaining bile ducts from dorsal and ventral sides enter.

A pair of salivary glands with very fine ducts discharge into the buccal mass after piercing the nerve ring. The glands themselves are set far back in the body, that on the right side immediately posterior to the genital complex, or about a third of the way down the body, that on the left side about half-way down. The glands are slender racemose tubes similar to those of *Armina*. They extend forwards beside the ducts, and spread out all round the gut and even over the buccal mass. The mouth aperture is protected by a pair of narrow jaw plates, in which, however, no trace of rod cells could be found. The radula (Text-fig. 24) is of a greenish colour and has 60 rows of very small teeth, the formula for the widest row being 140.1.1.1.140. This does not agree with the numbers given by Bergh and Eliot, who report 31 rows and a formula of 17.1.17, and 20 rows and a formula

of 12.1.12 respectively. The teeth have narrow oblong bases and fall off the membrane easily. The rachidian tooth is slight, its base being exceeded by the cusp in width. This cusp is very long, and the overhanging portion of the tooth extends more than half-way over the tooth in the succeeding row. The cusp is bifid at the apex, and bears on each side, after a considerable diastema, from 15 to 25 fine, regular, parallel denticles. The first lateral resembles half a rachidian tooth, but is short and almost square, its cusp hardly projecting beyond its base and bearing eight denticles. Then begins a series of increasingly simpler lateral teeth, each with a long curved and pointed cusp. The first eight show denticulations on the lateral face, the second lateral having from 6–8 denticles, the number being gradually reduced in the others until only one denticle is left. All the remaining teeth in the row are simple. On one side of the radula the 63rd lateral is bifid as if two teeth were fused, and this abnormality is repeated in row after row, though only the 63rd tooth is thus affected.

The hermaphrodite gland is a yellow elongated structure 9 mm. long and 3 mm. broad, lying on the right side, but with its free posterior end veering towards the mid-dorsal line. The hermaphrodite duct lies wholly superficially on its ventral side and the ductules can be plainly seen.

Armina semperi (Bergh). (Text-figs. 25, 26 and 27.)

Pleurophyllidia semperi, Bergh, S.R., 1870–75, p. 249.

Occurrence.—Sta. 194, Gulf of Aden, 7.v.34, 220 metres; twenty-one specimens, varying from 60 mm. long and 23 mm. broad to 30 mm. long and 12 mm. broad.

Distribution.—Indian and Pacific Oceans.

Descriptive Notes.—Bergh gave an account of the external features, jaws and radula of this species, but said very little about the general anatomy. As this differs in many respects from other species of the genus, the gut and reproductive system are here described in some detail.

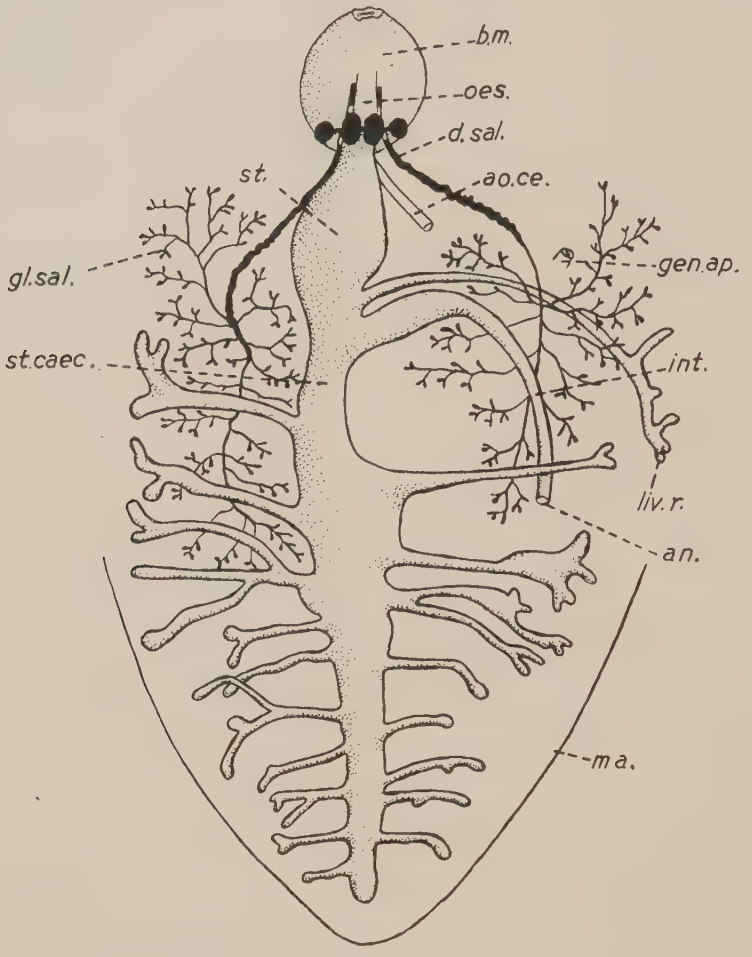
The preservation of the twenty-one specimens was on the whole good, though there was no trace of the reddish colour described by Bergh. Even the blackness of the mantle and the yellow edge of the longitudinal lines had largely disappeared in many of the specimens. The broad cephalic shield usually retained its yellow margin and the foot its bluish-grey colour. The recurved anterior broadened border of the foot, the paired gills beneath the anterior expanded mantle lobes and the lateral lamellæ extending the whole length of the remaining sub-pallial area were all typical. The unarmed penis was in many of the specimens extruded through the common genital aperture; between the latter and the anus lay the minute renal pore.

Alimentary canal.—The alimentary canal of *Armina* affords a good illustration of the Cladohepatic condition in Nudibranchs, for the hepatic branches extend to the extreme edge of the mantle, and since the hepatic diverticula are large and hollow, an instructive injection can be made of them (Text-fig. 25).

The buccal mass with its large horny jaws and compact radula have been described for this species by Bergh. The radula (Text-fig. 26) has about 40 rows, with a large broad central tooth, whose median cusp is finely denticulate, with from four to five cusps on each side of the median one. The side cusps form a fluted pattern. The first lateral is a short, broad, slightly curved tooth, triangular in cross-section, with fine denticulations on one

edge only. The remaining laterals, up to about 50 in number in the broadest part of the radula, are elongated and curved, at first with a few denticles near the middle of one side, but gradually becoming smooth (Text-fig. 26*b*, *c* and *d*).

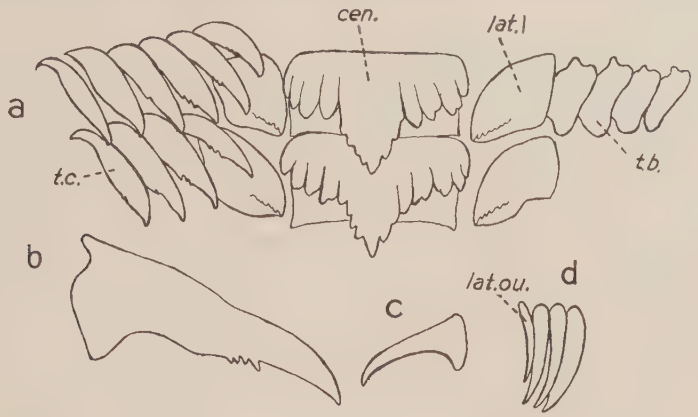
The paired ducts of the single pair of salivary glands pierce the nerve ring on their way to their apertures into the dorsal portion of the buccal mass beside the œsophagus. Each gland consists of from 18–20 much branched tubes (Text-fig. 25, *gl. sal.*), as fine as a



Text-fig. 25.—*Armina semperi*. Alimentary canal, dorsal view. × 2½.

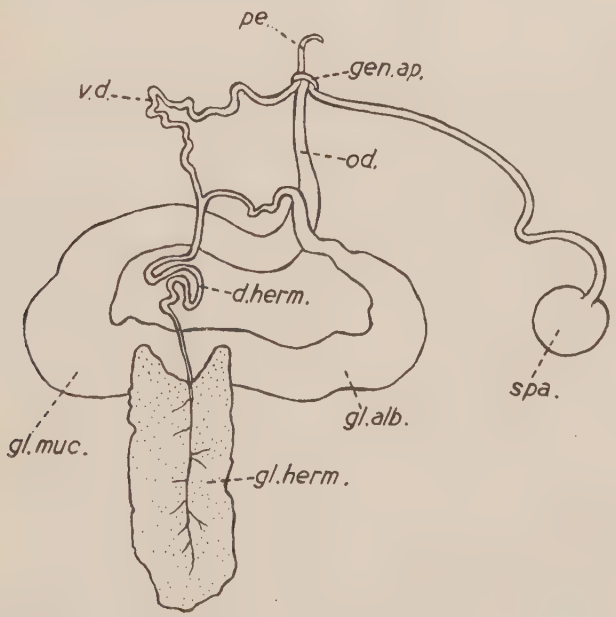
capillary network, lying ventral to all the body organs on the lower surface of the mantle. The main branches unite to form a single stem on each side, and this stem becomes the duct. It is convoluted as it passes forwards, but straightens as it nears the nerve ring. There is no trace of a second pair of salivary glands as described by Bergh in *A. californica*. The œsophagus widens to form the thin-walled stomach (*st.*), which is only slightly larger than the buccal mass. It lies on the animal's left side, ventral to the heart, and ventro-lateral to the voluminous reproductive organs. It receives from the right a wide thin-walled bile duct, bringing the discharge of five or six blunt diverticula situated at the edge of the overhanging mantle flap and representing the right liver lobe. The duct lies dorsal to the body organs and is placed transversely, anterior both to the intestine and the heart. Posteriorly the stomach contracts a little and gives off ventrally an elongated

stomach cæcum (*st. cæc.*), which extends to the posterior limit of the body. This cæcum receives the posterior bile ducts or left liver ducts, first a large unpaired duct on the left



Text-fig. 26.—*Armina semperi*. *a*, Part of two rows of the radula. On the left the cusps of the laterals are shown, on the right the bases of laterals 2–5. × 92. *b* and *c*, Lateral teeth. × 92. *d*, Outermost lateral teeth. × 92.

side and then irregularly arranged paired ducts. An injected specimen showed 10 main ducts on the left and 8 on the right side. These ducts are formed by the fusion of a system of reddish diverticula lying within the thinned edge of the mantle. No anastomosis of diverticula was found, though Bergh found such junctions in his specimen. The



Text-fig. 27.—*Armina semperi*. Scheme of reproductive apparatus.

intestine (*int.*) leaves the right posterior portion of the main stomach, turning forwards and dorsalwards over the genital complex. There is no valve separating it from either stomach or gastric cæcum, but a shallow fold, like a typhlosole, runs along its anterior wall. The intestine is short, and becomes more opaque as its walls increase in thickness. It soon takes a right-angled turn backwards and ventralwards, so that the horizontally

placed rectum lies ventral to the nearest hepatic cæcum but dorsal to the right salivary gland. It opens to the exterior on the right side of the body under cover of the mantle flap (*an.*).

Reproductive Organs.—*Armina* is hermaphrodite and the genital duct is monaulic (Text-fig. 27). The genital complex forms a compact mass lying on the right side of the body cavity, ventral to the heart and intestine, but dorsal to the rectum and right salivary gland, so that its anterior portion passes under the intestinal bridge on its way to the external aperture, lying at the same horizontal level as the anus but in the anterior third of the body. The posterior portion of the mass is formed by the hermaphrodite gland (*gl. herm.*), a large rounded or triangular body nearly 2 cm. long in the specimen figured. The dorsal side of the gland is formed by the apposition of two distinct halves, though these fuse ventrally. On separating the dorsal halves, the common hermaphrodite duct and its factors can be seen lying on the ventral fused portions. The duct passes straight forwards, then becomes strongly convoluted and thicker walled, forming the ampulla of the duct. The coils can be separated fairly easily. After this the duct straightens again and divides into male and female genital ducts. The male duct lies on the left. It is very long and convoluted. As it approaches the common genital aperture, packed with sperm, its walls thicken, then it becomes suddenly slender for its passage through the unarmed penis. The female portion of the duct courses transversely to the right, passing through the usual albumen and mucus glands, which are coiled, then straight forwards to the common genital aperture. Into this same aperture opens the strong duct of the spermatheca or copulatory vesicle (*spa.*).

Armina tæniolata Bergh. (Text-fig. 28; Pl. I, fig. 5.)

Armina tæniolata, Bergh, 1866, p. 239; Eliot, 1905*b*, p. 239, pl. v, fig. 1.

Occurrence.—Sta. 43, South Arabian Coast, near Kuria Muria Islands, 28.x.33, 83 metres; one specimen, 25 mm. long, 15 mm. wide and 6 mm. high.

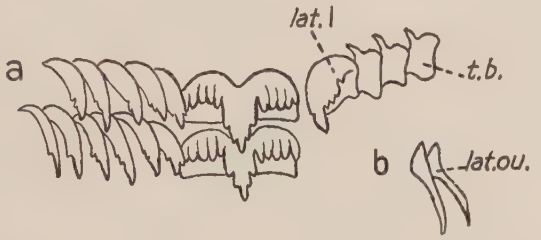
Distribution.—Indian Ocean.

Descriptive Notes.—The animal is black, with about 40 longitudinal yellow lines on its back, a yellow edge to the cephalic shield, and to the otherwise grey foot. The cephalic shield is not flat and oblong as in *A. semperi*, but has an auriculate margin, as in the oral tentacles of an *Aplysia*. Also the dorsal part of the shield projects over the head in front of the rhinophores as a flap. The rhinophores are bulbous, with longitudinal leaves held in place with a little button-like knob at the tip. The foot is rather thin, with a pronounced yellow rim and grey pedal surface. Posteriorly a pale median streak represents the posterior pedal gland. The anterior margin of the foot is thick, yellow and double, with the usual recurved lateral angles. The gills are well developed. There are about 10 leaves. The lateral lamellæ are very numerous, thick, reddish-brown flaps. There are 35 main lamellæ on the right side, but smaller ones fill the gaps, especially near the edge of the mantle.

The jaws are very delicate, less than half the size of those of *A. semperi* and more elliptical, with a very regular cutting margin made of eight rows of regular and almost symmetrical rod cells, rather pointed in shape. The radula (Text-fig. 28) has 34 rows, with a maximum formula of 32.1.32. It is rather small, with the basal membrane on

which the teeth are set extending well beyond the last tooth at the sides. The central tooth has a denticulate median cusp and 4 or 5 pairs of lateral cusps, the latter fluted as in other members of the genus. The first lateral is trihedral, its base almost square, but with a curved projecting process on its postero-lateral corner. The cusp has irregular denticles on its lateral face and some have a small denticle on the mesial edge. The remaining laterals are hooked, set on bases which are almost reniform in shape, becoming narrower and more curved as they proceed lateralwards. Each base (*t. b.*) has a very characteristic curved prolongation from its antero-mesial border. The cusp is long and stout, the first three or four teeth are blunt, but they become increasingly narrowed and more sharply pointed as the distance from the rachidial tooth increases. Denticulations occur nearly halfway down the outer edge of the laterals near the centre of the radula. The first 4–8 teeth bear three (rarely four) denticles, the next 4 teeth two denticles and about 8 further teeth have one denticle. The outer laterals (Text-fig. 28*b*) are simple. None of the teeth are bifid.

The salivary glands resemble those of *A. semperi*. The liver has six branches on the left side, and on the right side are six branches in addition to the main liver duct anterior to the intestine.



Text-fig. 28.—*Armina tæniolata*. *a*, As Text-fig. 26*a*. × 105. *b*, Two outermost laterals. × 105.

The auriculate tentacular shield, very numerous lateral lamellæ and the intense colour of this handsome species were described by Eliot (1905*b*). He also noted the peculiar prolongation of the tooth base on the laterals of the radula, which has not been figured or described in any other species of the genus. Eliot's specimen came from the same region.

Scyllæa pelagica Linn., var. *orientalis* Bergh.

Scyllæa pelagica var. *orientalis*, Bergh, S.R., 1870–1875, pp. 319 and 339 ; Eliot, 1906*a*, p. 675.

Occurrence.—A single specimen of this almost cosmopolitan pelagic form was collected by the Expedition, but no details of locality were given.

Descriptive Notes.—The animal exhibits no trace of colour or markings, and is somewhat compressed. The head bears a single pair of tentacles, the body two pairs of cerata with much branched branchiæ on their dorsal surfaces. The jaw shows small trifid rods. The radular formula is 21.1.21 and there are 17 rows of teeth. The details of the radula resemble those of Bergh's variety *S. pelagica* var. *orientalis*, but in the absence of any data regarding its location, colour and markings it is difficult to decide definitely. Bergh's variety occurred further east, off the islands of Cebu and Panay in the Philippine group.

SUMMARY AND CONCLUSIONS.

The collection consists of 23 species belonging to 18 genera, from the Red Sea, Gulf of Aden and the South Arabian coast as far east as Maskat. The specimens were taken from near the surface to a depth of 220 metres. Most have already been recorded for this area, though some are not common. Two genera are new to the region. *Phanerophthalmus* has hitherto been found in the Pacific ocean only; *Pleurobranchoides* is known from a single species (two specimens) off the coast of South Africa. On the other hand, the collection can hardly be said to be representative as regards the Nudibranchs. Whole families such as the Bornellidæ, Tethyiidæ, Æolidiidæ and Flabellinidæ are unrepresented, others like the Polyceridæ provide only a single species. Even in the Doridæ, which has the largest number of species, there is only one mangled specimen of the large genus *Glossodoris* (*Chromodoris*), one *Discodoris* and not a single *Dendrodoris* (*Doridopsis*).

There are two new species, and possibly a third. The former are *Artachæa intermedia* and *Phanerophthalmus collaris*. The genus *Artachæa* is confined to the Indo-Pacific area, its three previously known species extending from the Philippines and Japan to Zanzibar and the Red Sea. The new species, *A. intermedia*, from the Gulf of Aden, is in many respects a link between *A. rubida* Bergh and *A. clavata* Eliot. The genus *Phanerophthalmus* has hitherto been confined to the Pacific Ocean, where four species occur. The new species, *P. collaris*, also from the Gulf of Aden, is much broader than the Pacific members, has a large cephalic shield, well-defined eyes and rhinophores, a longitudinally placed, intra-pallial shell, and the foot divided into anterior and posterior regions, so that the parapodial lobes arising from the posterior part of the foot stand up like a collar around the head. The *doubtful* new species belongs to the genus *Pleurobranchoides* O'Donoghue. The single large specimen was badly torn, and though it agrees in many respects with the only known species from South Africa, *P. gilchristi*, it is much larger than the latter, and its radular characters show some differences. As the specimen is imperfect, however, a new name has not been given to it at present.

A useful corollary to the work on the Opisthobranchs collected by the Expedition would be a comparison showing the trends in evolution exhibited by the specimens. The two groups of organs from which most might be expected are the reproductive apparatus and the nervous system. The number of forms described is not large enough to make a comparison of the genital complex profitable, but the author has prepared schemes of the chief varieties amongst the members of this collection (See Text-figs. 12, 16, 18, 20, 23 and 27) in the hope that they will form a nucleus for future work. Such a comparison is badly needed; in the Doridæ alone the accessory genitalia are so imperfectly known that to quote these organs for classificatory purposes, as most systematists do, is bound to be confusing.

With regard to the nervous system, a comparison of the chief types, as shown by Text-figs. 1, 2, 6, 8, 11, 15, 19 and 22, provides a series exhibiting progressive concentration of the nervous system. The least specialized is *Bulla ampulla* (Text-fig. 2), the most specialized, *Hexabranchus sanguineus* (Text-fig. 11). In *Bulla* the cerebral, buccal, pedal, pleural and pallial ganglia (all paired) and the supra-intestinal, infra-intestinal, osphradial, visceral and genital ganglia (all unpaired) are distinct. The pairs, except the buccal, are

lateral in position. The unpaired group are linked with the paired group, through the pleuro-pallial ganglia, by a pair of uncrossed pleuro-visceral connectives, but in the most primitive Opisthobranchs, *e. g. Actæon*, *Akera*, etc., these visceral cords are crossed as in Prosobranchs. Right and left cords have a transverse communication across the ventral side of the gut. The first step in concentration is the incorporation of the left pallial ganglion with the left pleural ganglion (cf. *Phanerophthalmus*, Text-fig. 6), while on the right side the right pallial ganglion may fuse either with the right pleural ganglion (Text-fig. 6) or with the supra-intestinal ganglion (*Hydatina*, Text-fig. 1). Next the infra-intestinal and visceral ganglia, and sometimes also the genital ganglion, unite (Text-figs. 1, 6), then the pleurovisceral cords shorten (*Stylocheilus*, Text-fig. 8), and finally all the unpaired ganglia are incorporated in the nerve circle around the gut (Nudibranchs, Text-figs. 11, 15, 19 and 22), and lie on its dorsal side, like gems on a ring. The cerebral commissure is usually short and the cerebral ganglia may be in contact with one another, but the pedal commissure is at least equal to the remaining circumference of the œsophagus. In Nudibranchs the degree of concentration of the dorsal group of ganglia varies greatly. In *Nembrotha* (Polyceridæ) the ganglia are all distinct, with connectives linking the main cerebral, pedal and pleurovisceral ganglia (Text-fig. 15). In the Doridæ (Text-figs. 22, 19) the ganglia are still distinct, but the connectives are so much shortened that the ganglia become contiguous (*Artachœa*, *Asteronotus*). In the Hexabranchidæ (Text-fig. 11) the fusion is carried to its extreme, and the ganglia of the nerve mass can no longer be traced except by the nerves issuing from them. In the Nudibranchs a pair of new ganglia have arisen as outliers from the cerebral. These are the olfactory ganglia supplying the rhinophores. The eyes are usually sessile on the cerebral ganglia, the width between them being a character of different families and often of genera (cf. Text-figs. 11, 19, 22 and 15 for a series in eye-spacing). The eyes of Tectibranchs, on the other hand, though sessile on the skin, are usually connected with the cerebral ganglia by long slender nerves. These are not shown in the figures.

LIST OF REFERENCE LETTERS USED IN TEXT-FIGS.

a. Anterior end of gizzard plate.
amp. Ampulla of the hermaphrodite duct.
an. Anus.
an. con. Anal concavity of shell.
ao. ce. Cephalic aorta.

b. Bulb near vagina.
b. m. Buccal mass.
bd. l. First bile-duct.

cen. Central (rachidian tooth).
com. ce. Cerebral commissure.
com. ped. Pedal commissure.
con. ce. buc. Cerebro-buccal connective.
con. ce. ped. Cerebro-pedal connective.
con. ce. pl. Cerebro-pleural connective.
con. v. l. Left pleuro-visceral connective.
con. v. r. Right pleuro-visceral connective.

d. herm. Hermaphrodite duct.
d. sal. Salivary duct.
dt. Dart.
dt. s. Dart sac.

e. Eye.

f.a. Anterior portion of foot.
f.p. Posterior portion of foot.

g. buc. Buccal ganglion.
g. ce. Cerebral ganglion.
g. ce. pl. Cerebro-pleural ganglion.
g. gen. Genital ganglion.
g. inf. Infra-intestinal ganglion.
g. ol. Olfactory ganglion.
g. osphr. Osphradial ganglion.
g. pal. l. Left pallial ganglion.
g. pal. r. Right pallial ganglion.
g. par. Parietal (supra-intestinal) ganglion.
g. ped. Pedal ganglion.
g. pl. Pleural ganglion.
g. pl. l. Left pleural ganglion.
g. pl. r. Right pleural ganglion.
g. visc. Visceral ganglion.
gen. ap. Genital aperture.
gl. alb. Albumen gland.
gl. herm. Hermaphrodite gland.

gl. muc. Mucus (nidamental) gland.
gl. pr. Prostate gland.
gl. sal. Salivary gland.
gl. sal. p. Posterior salivary gland.
gl. ves. Vestibular gland.
gr. do. Dorsal groove of buccal mass.

int. Intestine.

lat. 1, 2, 34. First, second, thirty-fourth lateral tooth.
lat. ou. Outermost lateral tooth.
liv. Digestive gland.
liv. r. Right digestive diverticulum.

m. circ. Circular muscle of gizzard.
m. retr. Retractor muscle of penis.
ma. Mantle.
ma. l. Mantle lappet.
mo. Mouth.

ne. rh. Nerve to rhinophore.

od. Oviduct.
oes. Œsophagus.
ot. Otocyst.

p. Posterior end of gizzard plate.
pe. Penis.
pe. sh. Penis sheath.

r. Rodlet of jawplate.
b. r. Base of rodlet.

sp. Spine.
spa. Spermatheca.
spt. Spermatocyst.
st. Stomach.
st. cæc. Stomach cæcum.

t. b. Tooth base.
t. c. Tooth cusp.

u. Umbo.

v. d. Vas deferens.
vag. Vagina.

w. Wart or cushion for spine.

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DESCRIPTION OF PLATE I.

Fig. 1, *a* and *b*.—Two specimens of *Artachæa intermedia*. × 2. The lower specimen shows the thickness of the body and the blotches on the underside of the mantle.

Fig. 2.—*Phanerophthalmus collaris*. × 9.

Fig. 3.—*Halgerda willeyi*. × 2.

Fig. 4.—*Phyllidiella pustulosa*. × 2.

Fig. 5.—*Armina tæniolata*. × $1\frac{1}{3}$. Posteriorly the mantle skirt has turned upwards, exposing the lamellæ.

Fig. 6.—*Nembrotha lineolata*. × 3.

Fig. 7.—*Dermatobranchus striatus*. × $2\frac{1}{2}$.

Fig. 8.—*Hydatina velum*. × 4.

Photographs and enlargements by Mr. F. C. Padley.

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